ABSTRACT

Title of Thesis:	CRACK DETECTION BY DIFFERENTIAL LASER THERMOGRAPHY
	Rachel Ostrow Benedetto Master of Science, 2017
Thesis Directed By:	Professor Peter Chang, Civil and Environmental Engineering

Crack formation can be detrimental to the integrity of structures. Cracks can be difficult to detect, especially sub-surface cracks. This thesis creates a framework using laser point thermography, curve fitting, and multivariable regression to determine the location and characteristics of vertical cracks. It utilizes finite element modeling to create a two-dimensional cross section of steel and model fifty-two surface and internal cracks. It then fits a curve to the modified data for each crack. Multivariable regression determines a matrix that relates the curve fitting coefficients to the crack characteristics. This matrix is used to determine the characteristics of four cracks given the thermal data. The result is a very high accuracy in determining the location of a crack and less accuracy in determining the length and depth of the crack. This thesis shows potential for continued work using this framework for crack detection after experimentation and extruding it to three-dimensions.

CRACK DETECTION BY DIFFERENTIAL LASER THERMOGRAPHY

by

Rachel Ostrow Benedetto

Thesis submitted to the Faculty of the Graduate School of the
University of Maryland, College Park, in partial fulfillment
of the requirements for the degree of
Master of Science
2017

Advisory Committee:
Professor Peter Chang, Chair
Professor Amde Amde
Professor Jungho Kim

Acknowledgements

I’d like to thank my advisor, Professor Peter Chang for all his help in writing this thesis. I would also like to thank my wonderful husband, Dominik for his continued support.

Table of Contents

List of Tables

List of Figures

Chapter 1: Introduction

Structural health monitoring (SHM) is the act of applying a method to determine if any material irregularities exist in a structure. SHM is used in several industries including civil, mechanical, and aerospace engineering. The purpose of SHM is to find material inconsistencies that have the potential to decrease performance of the component and cause a possibility of eventual failure of the system. These inconsistencies are simply referred to as damage by Farrar and Worden. In their research, geometric property, material, or boundary condition changes all constitute damage (2007). The past twenty years have seen an increase in the quantity of research conducted in this field due to its potential to save lives and significant money long term by finding problems before they become too substantial (Farrar and Worden 2007). Non-destructive testing (NDT) is often used in SHM.

NDT is a means of checking a system or part of a system for any inconsistencies or changes in characteristics in which the process is not damaging to the components tested. NDT can be used when a component is created, as the system is assembled, or once it is in use. Many different approaches have been designed to conduct NDT; some of the most common approaches are magnetic particle testing, electromagnetic testing, radiographic testing, ultrasonic testing, liquid penetrant testing, and visual testing (ASNT 2017).

Infrared thermography is one method used for NDT. Two main classifications of infrared thermography exist: active and passive. Active thermography uses an

external source of excitation such as heat lamps, hot air guns, flash lamps, and ultrasound to create a temperature differential that is noticeable when using thermography. Passive thermography involves no induced excitation. It is often used when the object being inspected has an ambient temperature that is not the same as the surrounding area (Avdelidis et al. 2011).

Many studies have been conducted which show the effectiveness of using infrared thermography in non-destructive testing for materials such as composites, concrete, metals, ceramics, plastics, and even lumber (Broberg 2013 and Eom et al. 2008). Several recent studies conducted on steel have been performed using ultrasound excited thermography. In ultrasound excited thermography, ultrasound waves are applied to the material being tested. The cracks and other defects within the material will cause heat due to friction and thus can be spotted using infrared thermography. These studies have shown that prolonged exposure to the ultrasound excitation decreases heat produced by the process and because friction produces the heat, it is not entirely non-destructive (Plum and Ummenhofer 2013).

A study published in 2010 uses a combination of thermography and ultrasound to locate cracks in concrete. Thermography is first used to locate the vertical crack by heating the concrete specimen in an oven and recording the cooling using infrared cameras. Then ultrasound waves are used to estimate the depth of the cracks within the concrete. This study showed promise for using passive thermography after a time of direct sunlight to find areas of possible defects and then using ultrasound to further explore these areas (Aggelis et al. 2010).

Within infrared thermography, the most prevalent form is transient thermography, also known as pulsed thermography. When conducting transient thermography, the surface of the structure is flash heated, often by lamps. As the structure cools, thermographic images are taken. This method is very effective at finding defects parallel to the surface such as delamination in composites. Although this method is effective over a larger area, a similar method exists for detecting smaller defects called laser line and laser spot/point thermography. Laser line and laser spot/point thermography are more effective than using heat lamps for detecting cracks perpendicular to the surface, but it is more time consuming and only practical for analyzing small areas with a high likelihood of fracturing (Li et al. 2010).

One of the main disadvantages of thermography is that the imaging can best view the activity near the surface of the structure (Avdelidis et al. 2011). In a study conducted in 2015, infrared thermography was used to take images of stainless steel while the steel was undergoing fatigue testing. The result was that a change in temperature was only noticeable when the crack was half the width of the test piece. This study was done without adding outside heat (Barile et al. 2016).

Work was done in 2007 by Burrows, Rashed, Almond, and Dixon using laser spot imaging to attempt to dectect surface breaking cracks in mild steel, stainless steel, and bakelite. The experiment involved applying a laser to a point on a test piece of mild steel and then taking a thermal image of the circular spot of heat radiating from the point. The results of the study were positive, they determined it was possible to discover surface breaking cracks as the circular pattern of heat conduction was

dramatically disfigured, but the results were very limited by distance from the heat source. When heat source was positioned 6 mm away from the crack, the results were no longer detectable (Burrows et al. 2007).

Another paper published by Li, et analyzed the temperature change across micron cracks perpendicular to the surface of the material using laser point thermography (2010). They used second derivative imaging techniques to locate the cracks in a stainless steel specimen. Their results showed promise in using this method although the maximum distance they tested from crack to the laser point was less than 4mm. They could only detect cracks very close to the heat source because they imaged the block less than a second after the laser pulse was applied on the surface, One interesting conclusion from their work was that the temperature change across a crack is about the same for cracks over approximately 2μm (Li et al. 2010).

It is often difficult when only analyzing the thermal image of a heated piece of material to find small defects, but the discontinuities become more obvious when the result is subtracted from the expected result created by a mathematical model. This method is used by McMasters, Taylor, and Brooke in an early 2017 study in which laser heating is used on a steel component and the temperature field on the opposite side of the component is analyzed by subtracting a calculated temperature field. This study used nonlinear regression to relate the experimental and theoretical temperature fields which allowed for test accuracy without accurate knowledge of the material properties. It was found that even a small rise in temperature was easily found and the accompanying defect was detectable. The defect used in this experiment was a small

divot created by a drill bit in the side of the material where the laser heating occurred (McMasters et al. 2017). For in situ structures it is often not possible to access the opposite side of a material and readings must be taken on the side on which heat is applied.

This thesis works with the idea that temperature variances are more apparent when subtracting an expected temperature profile from the actual temperature profile of a cracked plate. In this thesis, all models are created using finite element software. In practice, this may be completed by taking a temperature profile of a few areas that are undamaged and using those as a baseline measurement. The purpose of this thesis is to create a framework to approximate the location and characteristics of vertical cracks in a steel specimen. It is intended to be developed for use in remote monitoring of structures, for example with the use of drones to both apply the heat source and conduct the thermal imaging. In order to be effective for remote monitoring of in situ structures, readings are taken from the same side of a piece of material that the laser heat source is applied. This thesis analyzes a two-dimensional plate that is taken as a slice of a larger three-dimensional block of flawless, isotropic carbon steel to simplify the problem. This slice is modeled using finite element software without flaws as a baseline and with a variety of different cracks. This thesis only discusses vertical cracks and is not expected to be effective for detection of horizontal cracks or delamination.

Chapter 2: Finite Element Modeling

Modeling a Plate Without a Crack

The first step in the process is to create a numerical model using finite element software to display heat conduction in the two-dimensional steel plate without a crack. The plate is assumed to be a slice out of a larger, three-dimensional specimen and therefore only the cord along the top is assumed to be visible for this thesis. ANSYS Mechanical APDL 18.2 is the software used for the modeling. A two-dimensional square plate is created that has a side length of 1.5 meters with the origin at the bottom left corner.

When creating the square, a line segment at the top with ends at Point A (0.75,1.5) and Point B (0.751,1.5) should be included and is representative of the area covered by the diameter of the laser. Also included are key points at Point C (0.5,1.5) and Point D (1.0,1.5) which are used to break the top chord of the plate into six separate line segments which will be important for meshing. Only a single, half-meter square portion at the top center of the plate with corners at C and D will be used in this analysis. The plate extends in each direction to ensure that the edges do not interfere with the heat transfer. The points are shown in Figure 1. The material used in this model has the following properties (carbon steel at 25°C): conductivity – 53.2 W/mK, specific heat – 443 J/kgm, emissivity – 0.7, and density - 7850 kg/m^3 (ECCS 2015). The difference between absolute zero and the zero for the active temperature scale is set to be 298K (25°C). This means that all values collected from the model are relative to 298K.

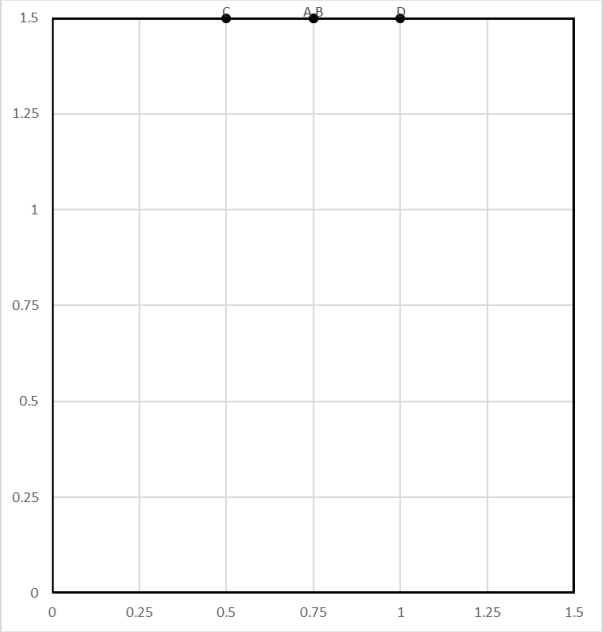


Figure 1: Cross Section Without a Crack in Two Dimension Showing Points A, B, C, and D

Thermal mass 8-node quadrilaterals (PLANE77) are chosen for the elements. These elements were chosen because they work well for two-dimensional, transient thermal analyses. These elements are also known to be able to model curved boundaries well. They can properly model either convections or heat fluxes on the surface of the plate (ANSYS Elements Manual). A mesh of these quadrilaterals is created. The mesh has elements of finer mesh near any cracks and heat source. The mesh size is specified at each line segment around the exterior of the plate. The three line-segments from Point A to Point B, Point C to Point A, and Point B to Point D all have element the side lengths of 1mm. The elements must be this small along these three line-segments to be able to extract thermal data every millimeter. All other line segments have a side length of 10mm. The peripheral areas have a larger element size to decrease the length of time needed to mesh the plate and run the analysis. The

meshed plate is shown in Figure 2. Figure 2a shows the entire meshed plate and Figure 2b is zoomed in to show the 100mm wide section along the top of the plate centered at Point A.

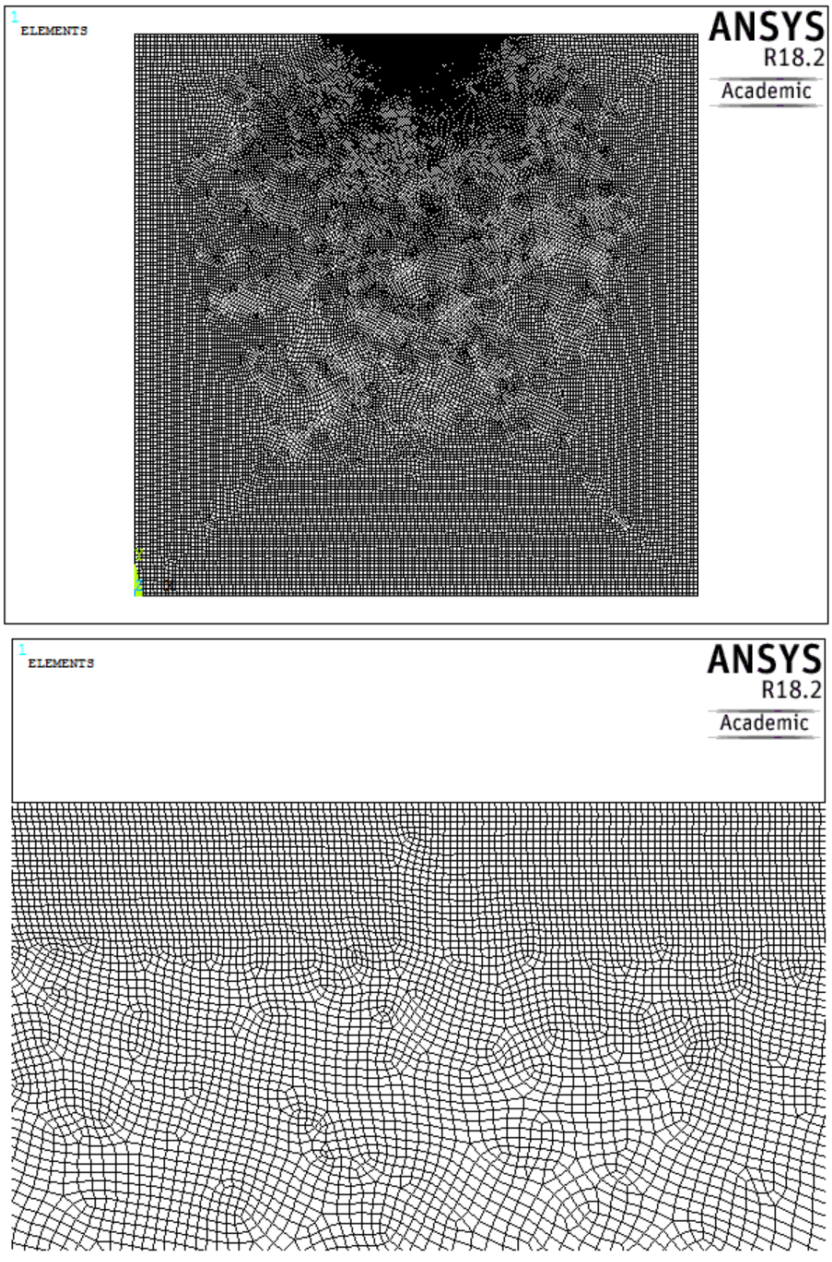


Figure 2: Meshed Plate with No Crack (a)Zoomed Out (b)Zoomed In

Each analysis is run as an individual transient analysis spanning a period of 125 seconds with a time step size of 5 seconds. For the first run, a temperature load of 500 degrees above ambient temperature is placed at Line Segment AB along the top of the cross section. The line segment is one-millimeter wide to symbolize the radius of a laser beam in contact with the surface of the specimen. The value for the temperature load is the heat that is absorbed by the surface of the material not the heat that is generated by the heat source. The thermal load is applied for the first 5 seconds of the period and then removed. Two minutes after the load is removed, the temperature results are recorded. The importance of the 125 second time duration as well as other assumptions used in modeling will be discussed later in this paper.

A path is defined in ANSYS to record temperature results along the top of the plate. The path covers the line segment from Point C to Point D. Using the function Map onto Path, the temperature along the path is recorded at time, t=125 seconds. Along this line, data points are recorded at one-millimeter intervals. These values are logged in the Excel spreadsheet, shown in Appendix A and used as a baseline for how the heat should transfer across a plate without defects. Figure 3 below shows a contour plot of nodal temperature at time, t=125 seconds.

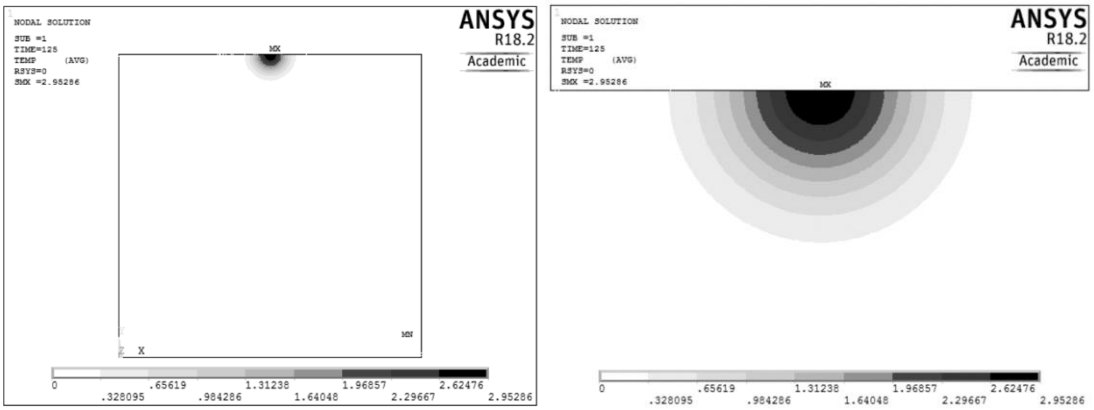


Figure 3: Contour Plot of Nodal Temperature (a)Zoomed Out (b)Zoomed In

Determining Which Cracks to Model

The purpose of this thesis is to locate and determine characteristics of vertical cracks and determine if it is feasible to use laser point thermography to find cracks at up to 10 cm away from the heat source. To do this, many different cracks must be modeled. Three parameters are used to describe the cracks modeled in this thesis. These parameters are labeled *x*, *d*, and *l*. Component *x* refers to the horizontal distance from Point A, the left side of where the heat source is applied, to the top left corner of the crack. Component *d* refers to the depth of the top of the crack beneath the surface and *l* refers to the length of the crack. The width of each crack is one-tenth of a millimeter. The parameters are shown in Figure 4 below.

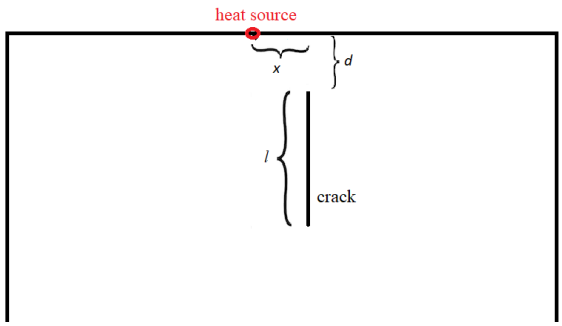


Figure 4: Diagram of Crack Characteristics

In this thesis, four different *x* values (10cm, 5cm, 3cm, and 1cm), three different values of *l* (10cm, 5cm, and 2.5cm), and six different values of *d* (0cm, 0.25cm, 0.5cm, 1cm, 2.5cm and 5cm) are studied. This creates a possible 72 cracks to be modeled. A temperature difference threshold of 0.1K was created and is discussed in the Modeling Assumptions section of this paper. All models with a max temperature difference that did not meet the temperature threshold were not used in this paper, this included all cracks with *d* values equal to 5cm and many with *d* values equal to 2.5cm. A description of each modeled crack that met the threshold is shown in Table 1. Cracks designated with an *S* are surface cracks and cracks designated with an *I* are internal cracks.

Table 1: List of All Cracks

Designation	x	d	l	Designation	x	d	l
S1	10	0	10	**I15**	5	0.5	2.5
S2	10	0	5	**I16**	5	1	10
S3	10	0	2.5	**I17**	5	1	5
S4	5	0	10	**I18**	5	1	2.5
S5	5	0	5	**I19**	5	2.5	10
S6	5	0	2.5	**I20**	5	2.5	5
S7	3	0	10	**I21**	3	0.25	10
S8	3	0	5	**I22**	3	0.25	5
S9	3	0	2.5	**I23**	3	0.25	2.5
S10	1	0	10	**I24**	3	0.5	10
S11	1	0	5	**I25**	3	0.5	5
S12	1	0	2.5	**I26**	3	0.5	2.5
I1	10	0.25	10	**I27**	3	1	10
I2	10	0.25	5	**I28**	3	1	5
I3	10	0.25	2.5	**I29**	3	1	2.5
I4	10	0.5	10	**I30**	3	2.5	10
I5	10	0.5	5	**I31**	3	2.5	5
I6	10	0.5	2.5	**I32**	1	0.25	10
I7	10	1	10	**I33**	1	0.25	5
I8	10	1	5	**I34**	1	0.25	2.5
I9	10	1	2.5	**I35**	1	0.5	10
I10	5	0.25	10	**I36**	1	0.5	5
I11	5	0.25	5	**I37**	1	0.5	2.5
I12	5	0.25	2.5	**I38**	1	1	10
I13	5	0.5	10	**I39**	1	1	5
I14	5	0.5	5	**I40**	1	1	2.5

Modeling Cracked Plates

Each of the fifty-two cracks in Table 1 were modeled using ANSYS. The cracks are modeled by removing the cracked area from the area of the plate using the Booleans: Subtract tool in ANSYS. For example, Crack S1 is formed by creating a rectangle with corners at (0.85, 1.5), (0.85, 1.4), (0.8501, 1.4), and (0.8501, 1.5) and subtracting them from the plate. The model containing the subtracted area is then meshed again using the PLANE77 element. All element side lengths are the same as those used previously except the line segments created by the crack. The line segments created by the crack are meshed with element side lengths of 0.1mm. The elements are the same size as the width of the crack consequently one element can be placed along the top of the crack without creating bad element geometry at such a critical location.

As with the previous plate, an analysis is run with a heat source on line segment AB for five seconds. The temperature is recorded at time, t=125 seconds along line segment CD as previously discussed. Data points are recorded every millimeter along the line segment. Figure 5 below shows a contour plot of the nodal temperatures for two models, the first containing Crack S1 and the second containing Crack I40.

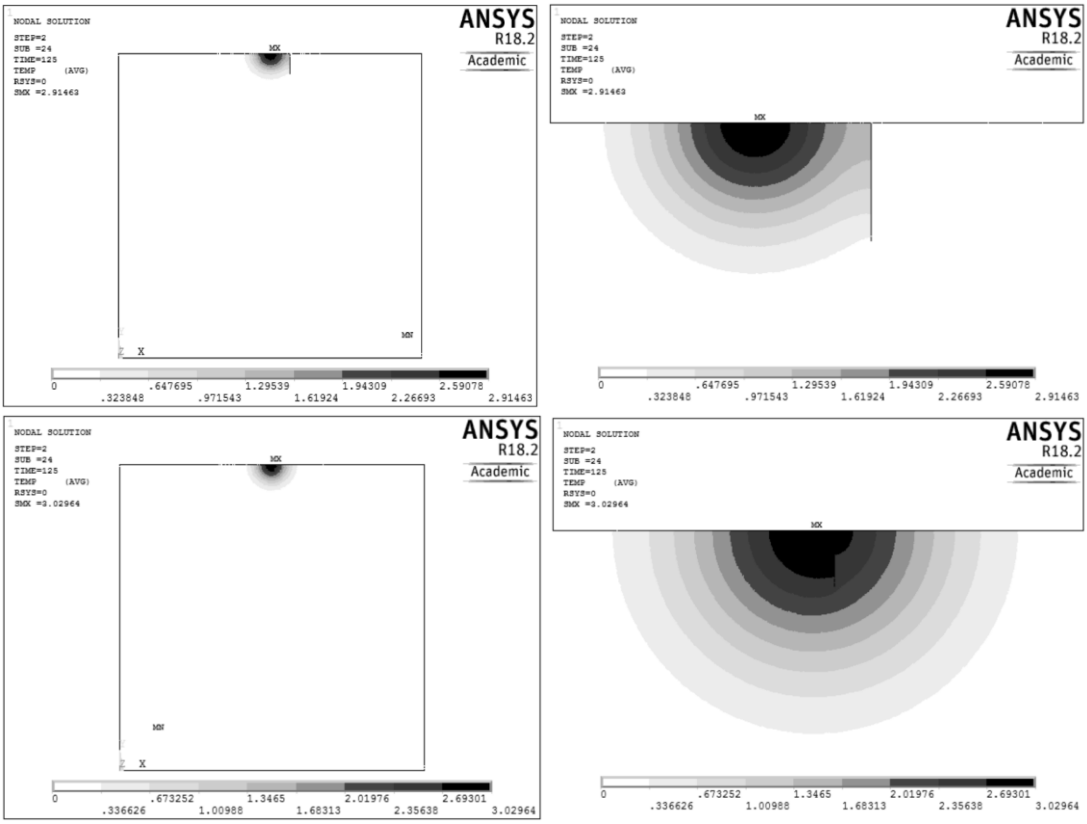


Figure 5: Contour Plot of Plate with Crack (a) S1 Zoomed Out (b) S1 Zoomed In (c) I40 Zoomed Out (d) I40 Zoomed In

The temperature along the line segment between points C and D is collected at every millimeter and recorded in the spreadsheet shown in Appendix A. The temperature profile for each crack is shown on a separate page in the appendix. The temperature profile includes this raw data and the calculated data discussed in the next Chapter. Graphs of the raw data for cracks S1 and I40 are shown in Figure 6 below.

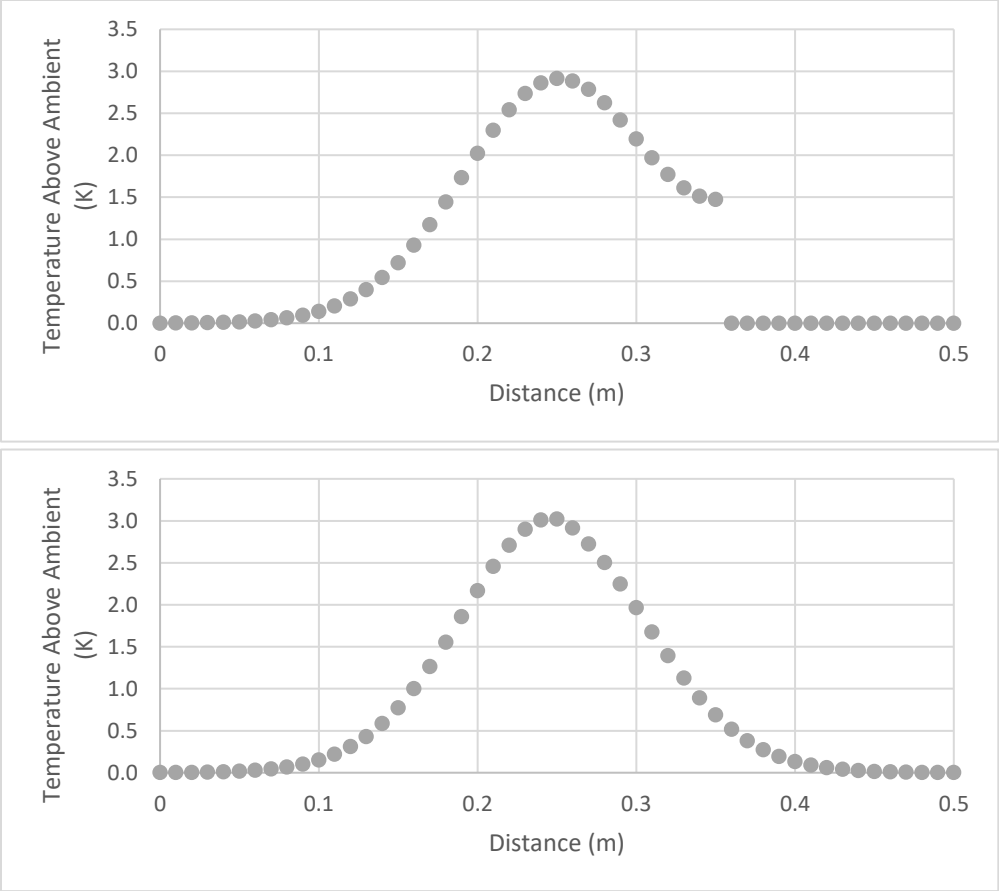


Figure 6: Temperature Curve for Crack (a)S1 (b)I40

Modeling Assumptions

The baseline analysis was run without including the impact of convection and radiation along the top of the plate. Another model was created incorporating convection along the surface. The convection film coefficient used was 10 W/m^2K, an average value for free convection by a gas (Incropera et al. 2007). The temperature at all points along the surface was between 1.3% to 1.4% (up to 0.04 K) different from the baseline analysis. The same analysis was done implementing radiation along the edge of the plate between the plate and the surrounding area and assuming that the plate was originally the same ambient temperature as the space around it. The model

with radiation had a constant 0.6% (up to 0.02 K) variation from the initial plate. Convection and radiation along the top of the plate between the surface and the surroundings have approximately the same effect for both a cracked and non-cracked plate. Since this thesis uses the difference between a model plate and a cracked plate between which the temperature variance is small, these effects become negligible and are not included. In practical applications, the baseline temperature may be a thermal profile taken from undamaged areas of the structure and thus will have radiation and convections relatively the same as that of the damaged areas.

The model for surface crack S4 was also run with radiation across the crack from one surface to the other. The largest change this made to the temperature profile across the analyzed path was less than 0.01 K. Since this effect is so small and it added a significant amount of time to the running of each model, radiation across the crack is also not included in this thesis. The combination of neglecting convection and radiation both across the crack and along the edge of the model create roughly 2.5% error in the models.

The most precise thermal imaging cameras have a thermal sensitivity of less than 0.02K (FLIR 2014). Total error includes the combination of the 2.5% error in the model and the 0.02K camera sensitivity. A temperature threshold of 0.1K was set to make up for the combination of these errors and the noise that will exist in practical applications. All temperature values are rounded to the hundredth of a degree to comply with the maximum camera sensitivity. In practice, an analysis shall be done

on a few undamaged areas to determine what degree of noise and variation exist without a crack present to determine a reasonable tempearature threshold.

Initially, several different time durations were tested and the temperature difference at the highest point for multiple cracks were tested for times ranging from 5 seconds to 305 seconds. The maximum temperature change across the cracks for the material tested occurred most often between 100 and 150 seconds. Therefore, 125 seconds was chosen as the test duration.

Chapter 3: Data Analysis

Temperature Differential

Figure 6a, where a surface crack is present, clearly indicated the existence of a sudden temperature gradient and in Figure 6b, where a subsurface crack is present, it is difficult to notice a change visually compared to the baseline analysis. In order to highlight the temperature change, the results without a crack are subtracted from the results for each crack. This is done using the spreadsheets in Appendix A. These results are normalized to the temperature load that was set previously. They are multiplied by 1000 degrees, then divided by the applied temperature (500 degrees). The results for cracks S1 and I20 are plotted below in Figure 7 to show the change in temperature due to the crack. Normalizing the temperature allows the model to work for different temperature heat sources. The presence of a crack is significantly more noticeable when analyzing the processed data in Figure 7 compared to the raw data in Figure 6, especially for internal cracks.

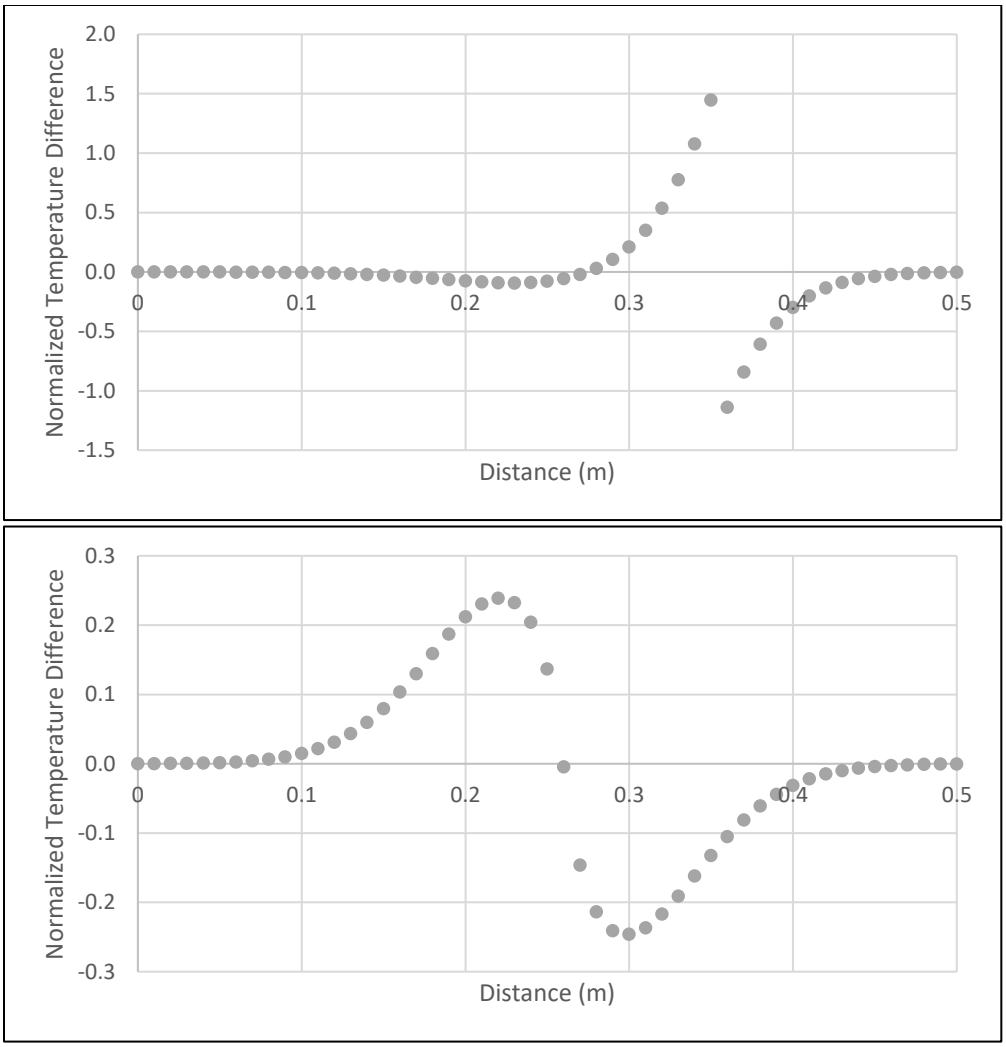


Figure 7: Graph of Temperature Change for Crack (a)S1 (b)I40

Best-Fit Analysis

This section of the paper focuses specifically on crack S7 to show the process of transforming the data points to the best fit curve coefficients. This crack has a horizontal distance from the heat source of 3 cm and a length of 10 cm. S7 was modeled using the method described in the Crack Modeling section of this paper. Table 2 below shows the processed data as described in the temperature differential section of this chapter. Figure 8 is a graphical representation of this data.

Table 2: Raw Data for Crack S7

Distance (m)	Temperature (K)			Distance (m)	Temperature (K)		
	No Crack	Crack	Normalized Difference		No Crack	Crack	Normalized Difference
0	0.0013	0.0014	0	0.26	2.9152	4.8962	3.96
0.01	0.0023	0.0023	0	0.27	2.7977	5.0528	4.51
0.02	0.0039	0.0039	0	0.28	2.6103	5.106	4.99
0.03	0.0065	0.0066	0	0.29	2.3683	0.0064	-4.72
0.04	0.0106	0.0108	0	0.3	2.0903	0.006	-4.17
0.05	0.0171	0.0176	0	0.31	1.7955	0.0053	-3.58
0.06	0.0271	0.028	0	0.32	1.5018	0.0045	-2.99
0.07	0.0423	0.0439	0	0.33	1.2239	0.0037	-2.44
0.08	0.0649	0.0676	0.01	0.34	0.9724	0.0029	-1.94
0.09	0.0976	0.1023	0.01	0.35	0.7538	0.0022	-1.5
0.1	0.144	0.1521	0.02	0.36	0.5705	0.0016	-1.14
0.11	0.2083	0.2217	0.03	0.37	0.4219	0.0011	-0.84
0.12	0.295	0.3169	0.04	0.38	0.305	0.0008	-0.61
0.13	0.4088	0.444	0.07	0.39	0.2158	0.0005	-0.43
0.14	0.5541	0.6092	0.11	0.4	0.1496	0.0003	-0.3
0.15	0.7339	0.8185	0.17	0.41	0.1016	0.0002	-0.2
0.16	0.9491	1.0762	0.25	0.42	0.0677	0.0001	-0.14
0.17	1.1975	1.3843	0.37	0.43	0.0442	0.0001	-0.09
0.18	1.4731	1.7414	0.54	0.44	0.0284	0	-0.06
0.19	1.7658	2.1422	0.75	0.45	0.0179	0	-0.04
0.2	2.0613	2.5766	1.03	0.46	0.0111	0	-0.02
0.21	2.3418	3.0302	1.38	0.47	0.0068	0	-0.01
0.22	2.5883	3.4849	1.79	0.48	0.0041	0	-0.01
0.23	2.7819	3.9199	2.28	0.49	0.0024	0	0
0.24	2.907	4.3135	2.81	0.5	0.0014	0	0
0.25	2.9528	4.645	3.38				

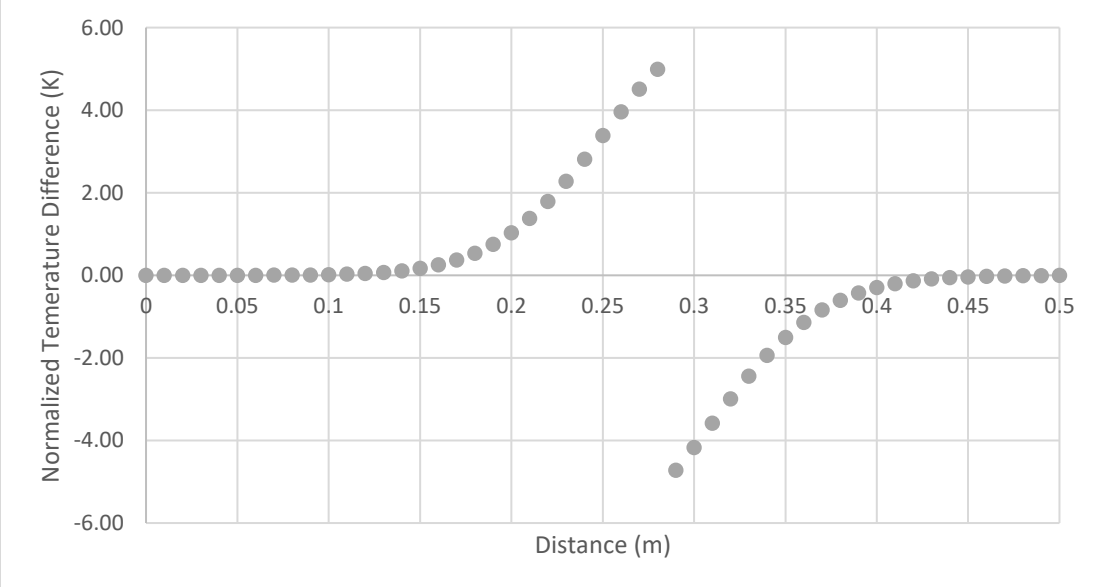


Figure 8: Graph of S7 Normalized Temperature Change

Each set of data points has the x-values shifted by a value x_o so that the point at which the best-fit curve crosses the x-axis is at the origin. This is done by finding the location at which the y-value of the data switches from positive to negative. The positive data point is identified as (x_1,y_1) and the negative as (x_2,y_2). To approximate the location where the best-fit curve crosses the x-axis, x_o is interpolated using the following equation:

$$x_o = x_1 + \frac{y_1}{y_1 - y_2}(x_2 - x_1) \qquad \text{(Equation 1)}$$

The x_o is then subtracted from fifteen points on each side of the new origin, meaning thirty data points now exist for each model instead of fifty. This allows the best fit line to more accurately reflect the pertinent portion of the data. Table 3 below shows the modified data used to determine the best-fit curve.

Table 3: Modified Data for S7

Shifted Distance	Normalized Temperature Difference	Shifted Distance	Normalized Temperature Difference
-0.1451	0.1102	0.0049	-4.7237
-0.1351	0.1692	0.0149	-4.1686
-0.1251	0.2543	0.0249	-3.5804
-0.1151	0.3736	0.0349	-2.9946
-0.1051	0.5366	0.0449	-2.4405
-0.0951	0.7528	0.0549	-1.9391
-0.0851	1.0306	0.0649	-1.5033
-0.0751	1.3768	0.0749	-1.1378
-0.0651	1.7932	0.0849	-0.8415
-0.0551	2.2760	0.0949	-0.6085
-0.0451	2.8130	0.1049	-0.4307
-0.0351	3.3844	0.1149	-0.2985
-0.0251	3.9620	0.1249	-0.2027
-0.0151	4.5102	0.1349	-0.1350
-0.0051	4.9914	0.1449	-0.0883

The basis functions chosen to best describe the surface data is a positive negative peak function described by the following basis functions:

$$f(x) = \frac{a_1}{(1+e^{b_1*|x|})} * (x < 0) + \frac{a_2}{(1+e^{b_2*|x|})} * (x > 0) \qquad \text{(Equation 2)}$$

This function fits the surface crack data well by adjusting the coefficients a1, a2, b1, and b2. This function is not as good for the subsurface data. To best fit both sets of data with one equation, the following set of basis functions is used:

$$f(x) = \frac{a_1}{(1+e^{b_1*|x|})} * (x < 0) + \frac{a_2}{(1+e^{b_2*|x|})} * (x > 0) \qquad \text{(Equation 3)}$$

$$+c_0 + c_1 \sin(wx) + c_2 \sin(2wx) + c_3 \sin(3wx) + c_4 \sin(4wx)$$

Using the MATLAB code shown in Appendix B, a best-fit curve is created, and the coefficients of the equation are determined for each set of data. Crack S7 was fit to both equations above, and the resultant coefficients are listed in Table 4 below.

Table 4: S7 Best Fit Coefficients

Coefficient	Full Equation (EQ3)	Peak Function Only (EQ2)
X_o	0.2851	0.2851
a1	11.1233	11.2348
a2	10.1643	10.4927
b1	23.1297	26.1469
b2	26.1257	27.9341
w	0.4155	
c0	-0.077	
c1	-1.0168	
c2	0.9842	
c3	-1.2523	
c4	1.9266	

Internal cracks are only fit to Equation 3, but Surface cracks are best fit to both Equation 2 and Equation 3. The reason for this will be explained in the Surface

Crack section of this paper. Figure 9 shows the best fit curves created by MATLAB overlaying the data points.

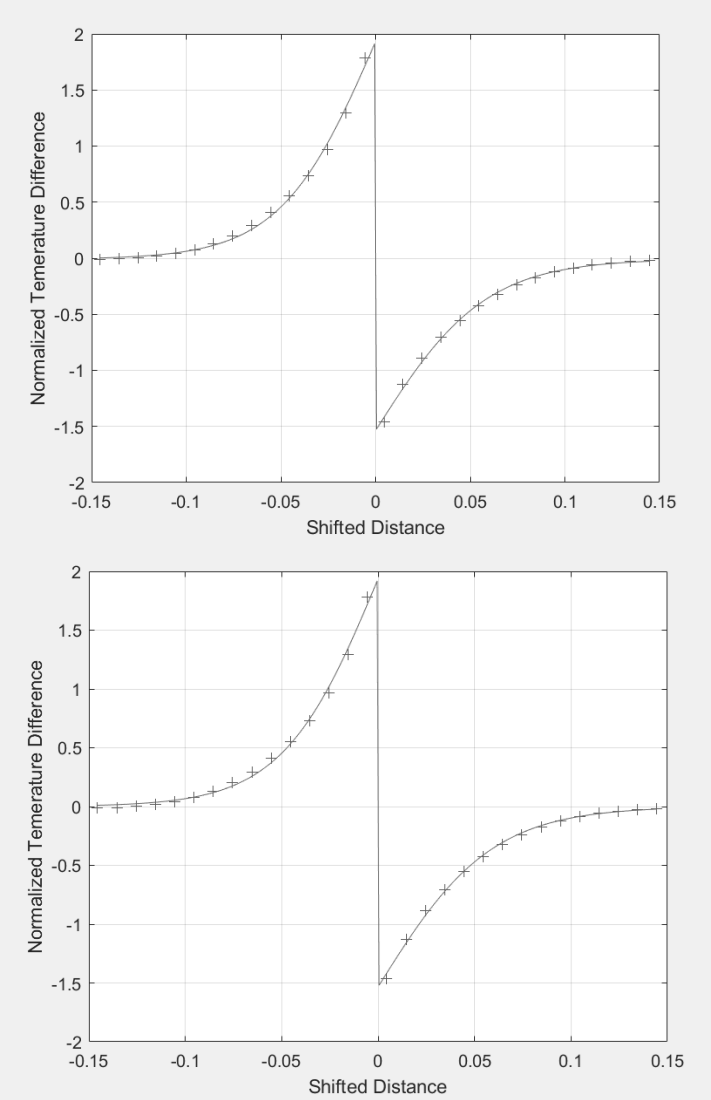


Figure 9: MATLAB Best Fit Curves S7 (a) Equation 3 (b)Equation 2

The best-fit curve was created for all fifty-two cracks. The functions fit the data points almost perfectly for the surface cracks. For some of the internal cracks the curve fit well while others had more pronounced errors. Figure 10 below shows examples of three best fit curves for internal cracks I3, I18, and I36.

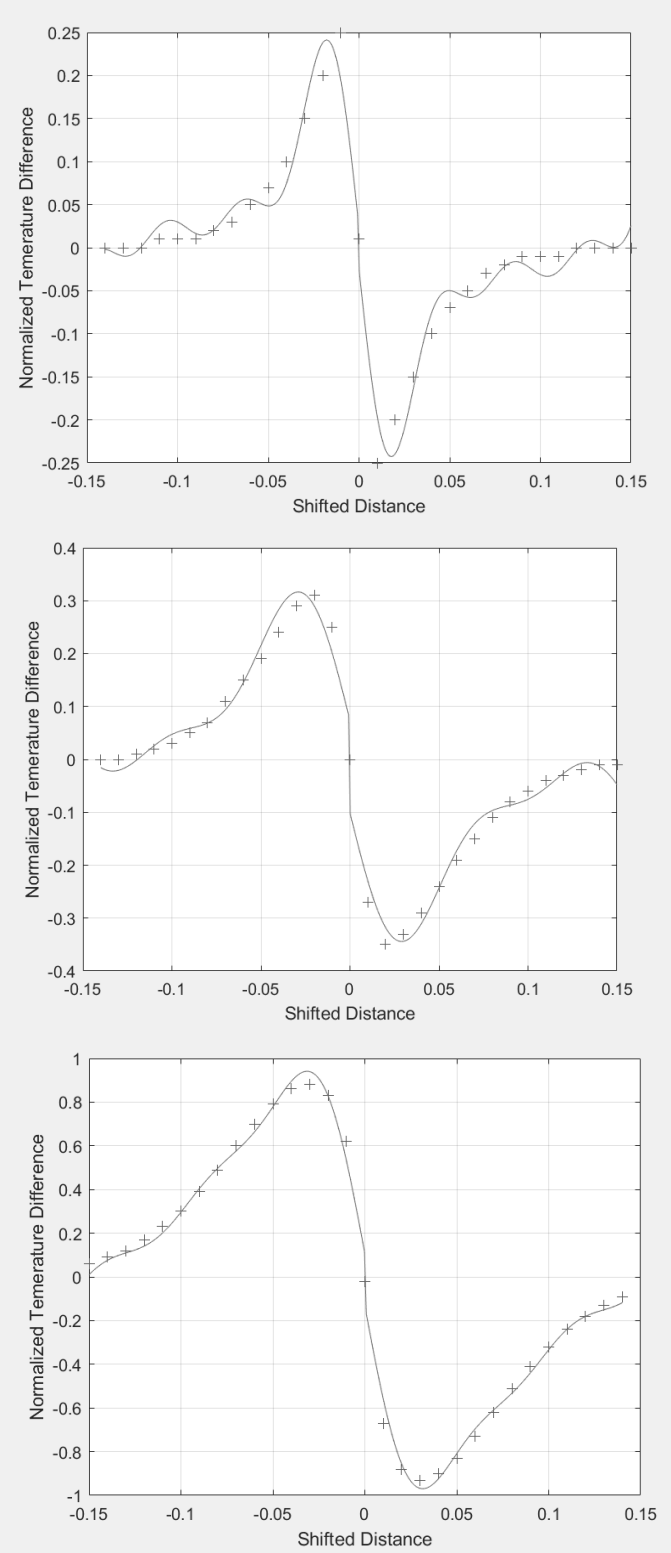


Figure 10: MATLAB Best Fit Curves (a)I3 (b)I18 (c)I36

The x_o value discussed above is the shift relative to Point C, the left side of the collected temperature profile. The location of the heat source (0.25m) is subtracted from the x_o value to get a more useful value for later analysis. This value is called the *S* value. The table is Appendix C shows the Equation 3 coefficients for all cracks described in Table 1, including the newly defined *S* value. Table 5 below is a summary of the coefficients. It shows the average, minimum, and maximum value for each coefficient broken up between surface and internal cracks.

Table 5: Summary of Equation 3 Coefficients

		S	a1	a2	b1	b2	w	c0	c1	c2	c3	c4
Surface Cracks	**Average**	0.05	6.55	6.09	32.23	34.33	0.00	-0.01	-0.05	0.20	-0.12	0.06
	Low	0.01	2.26	1.32	16.19	16.72	-0.63	-0.08	-1.02	-0.04	-1.25	-0.86
	High	0.11	12.27	12.72	59.70	65.94	0.42	0.08	0.49	0.98	0.20	1.93
Internal Cracks	**Average**	0.05	0.25	0.35	0.14	-0.06	24.04	0.02	-0.27	-0.28	-0.11	-0.08
	Low	0.01	-0.22	-0.12	-0.53	-0.80	18.81	-0.10	-0.74	-0.81	-0.28	-0.29
	High	0.10	1.03	1.07	0.81	0.41	33.10	0.19	0.00	-0.05	-0.03	-0.01

The tabular data in Table 5 shows some very clear distinctions between surface and internal cracks. The largest distinctions occur in the *b1*, *b2*, and *w* values. No internal cracks are present with *b1* or *b2* values greater than 1.0 and no surface cracks have *b1* or *b2* values less than 16. On the other hand, internal cracks all have *w* values greater than 18 and all surface cracks have *w* values less than 1.0. In order to best analyze the cracks, they are broken up into surface and internal cracks. For unknown cracks, the values of *b1*, *b2*, and *w* are important for differentiation. The value *R* calculated using the following equation is used to determine if a crack is a

surface or internal crack. If R is a positive number, the crack is a surface crack and if R is a negative number, the crack is internal.

$$b1 + b2 - w = R \qquad \text{(Equation 4)}$$

The next two sections of this thesis will discuss surface cracks and internal cracks, respectively, and the regression from the best-fit curve to a matrix that relates the curve coefficients to the crack characteristics. The matrix that maps from best-fit coefficients to the crack characteristics is called the β matrix. This matrix is limited in its use. It can only be used when the material properties and test time duration are the same as that used to create it, it can also only be used on vertical cracks within the analyzed x, d, and l ranges and with a normalized temperature as discussed in the beginning of this chapter.

Surface Cracks

Surface cracks are considered more easily identified than subsurface cracks, but sometimes even surface cracks can be difficult to detect visually. This section of the thesis analyzes modeled surface cracks. This includes cracks where d is equal to zero. The properties of these twelve surface cracks are shown again in the table below.

Table 6: Surface Crack Parameters

Crack Designation	Distance (x)	Crack Length (l)
S1	10 cm	10 cm
S2	10 cm	5 cm
S3	10 cm	2.5 cm
S4	5 cm	10 cm
S5	5 cm	5 cm
S6	5 cm	2.5 cm
S7	3 cm	10 cm
S8	3 cm	5 cm
S9	3 cm	2.5 cm
S10	1 cm	10 cm
S11	1 cm	5 cm
S12	1 cm	2.5 cm

The process discussed in the Best Fit Analysis section of this chapter for determining the best-fit coefficients was used on each of these cracked models. They have been fit to both the set of basis functions containing only peak functions and the set of basis functions including the sine functions (Equation 2 and Equation 3). Table 7 below shows the coefficients for each crack for Equation 3 and Table 8 shows the coefficients for each crack for Equation 2. Both tables include the *S* value previously calculated.

Table 7: Equation 3 Coefficients for Surface Cracks

	S	a1	a2	b1	b2	w	c0	c1	c2	c3	c4
S1	0.11	3.48	2.44	44.30	51.80	0.31	-0.07	-0.07	0.45	0.20	-0.28
S2	0.11	3.20	2.20	48.59	54.46	0.01	-0.05	-0.06	0.06	0.06	-0.05
S3	0.11	2.26	1.32	59.70	65.94	0.00	-0.04	0.00	-0.03	0.01	0.00
S4	0.06	9.27	7.82	30.15	33.37	0.00	-0.02	0.00	-0.01	0.00	0.00
S5	0.06	7.67	6.55	32.41	34.08	-0.01	-0.03	0.02	0.00	-0.01	0.00
S6	0.06	3.88	3.06	39.87	34.66	-0.01	-0.01	0.00	-0.01	-0.01	0.00
S7	0.04	11.12	10.16	23.13	26.13	0.42	-0.08	-1.02	0.98	-1.25	1.93
S8	0.04	8.92	8.45	24.19	24.93	-0.63	0.03	0.49	0.95	-0.44	-0.86
S9	0.04	3.68	3.51	26.83	24.66	-0.08	0.02	0.02	0.02	-0.01	-0.02
S10	0.01	12.27	12.72	21.11	23.15	0.00	0.00	-0.03	-0.01	0.01	0.00
S11	0.01	9.76	10.42	20.29	22.07	-0.01	0.01	-0.02	-0.01	0.01	0.00
S12	0.01	3.07	4.46	16.19	16.72	0.00	0.08	0.01	-0.04	0.03	-0.01

Table 8: Equation 2 Coefficients for Surface Cracks

	S	a1	a2	b1	b2
S1	0.11	3.42	2.50	49.69	45.43
S2	0.11	3.16	2.24	53.15	47.50
S3	0.11	2.24	1.35	66.88	54.11
S4	0.06	9.24	7.84	30.50	32.90
S5	0.06	7.65	6.57	32.97	33.39
S6	0.06	3.88	3.06	40.38	34.15
S7	0.04	11.23	10.49	26.15	27.93
S8	0.04	9.22	8.53	26.26	27.43
S9	0.04	3.70	3.49	26.17	25.28
S10	0.01	12.27	12.72	21.11	23.14
S11	0.01	9.78	10.40	20.22	22.16
S12	0.01	3.23	4.31	15.06	17.70
S13	0.04	7.21	10.95	65.09	32.04

Now that each crack has been analyzed, the data must be transformed into information that will be useful in identifying cracks when the dimensions and location of the crack are not already known. Multi-variable linear regression is used to relate *S*, *a1*, *a2*, *b1*, and *b2* back to the *x* and *l* values. The regression is performed using the MVREGRESS function in MATLAB, the code is attached in Appendix B. The result of the multi variable linear regression is a 5x2 matrix (β_S). When a 1x5 matrix including the Equation 2 coefficients for a single surface crack is multiplied by β_S, the *x* and *l* dimensions of the crack are the result. This calculation is described by Equation 5 below:

$$[S \quad a1 \quad a2 \quad b1 \quad b2]\, x\, \beta_S = \begin{bmatrix} x \\ l \end{bmatrix} \qquad \text{(Equation 5)}$$

The β_S matrix is:

$$\beta_S = \begin{bmatrix} 108.0 & 226.6 \\ 0.002 & -0.1857 \\ 0.0149 & 1.2809 \\ 0.0221 & -0.1678 \\ -0.0553 & -0.2165 \end{bmatrix}$$

The matrix of best-fit coefficients must be created using the same material and time duration as the data used to create the β matrix for its use to be appropriate in determining crack characteristics. As a method of testing this resultant β Matrix, the peak function coefficients are multiplied by the matrix to determine if it accurately calculates the surface crack parameters. Table 9 below shows the resultant parameters compared to the actual parameters and the percent error for each category.

Table 9: Check of β_S Matrix

Actual		Regression Results		Error (cm)	
x	l	x	l	x	l
10	10	10.0	8.3	0.0	1.7
10	5	10.0	7.0	0.0	2.0
10	2.5	10.0	2.4	0.0	0.1
5	10	5.0	8.6	0.0	1.4
5	5	5.0	6.8	0.0	1.8
5	2.5	5.1	1.6	0.1	0.9
3	10	3.0	8.9	0.0	1.1
3	5	3.0	6.8	0.0	1.8
3	2.5	3.0	1.9	0.0	0.6
1	10	1.0	8.8	0.0	1.2
1	5	1.0	6.7	0.0	1.7
1	2.5	1.0	1.8	0.0	0.7

It can be concluded from the table above that the β_S matrix is highly accurate in determining the location of the crack and is less accurate at determining the length of the crack, although it is still good approximation. The largest error of the length of the cracks was found to be 2.0cm. This result is reasonable, because the *S* value gives a fairly accurate approximation of the location of the crack without the use of the other peak function coefficients.

Internal Cracks

As stated earlier, internal cracks perpendicular to the surface are difficult to detect. This section of the thesis includes all cracks where *d* is not equal to zero. The properties of these forty internal cracks are shown again in the table below.

Table 10: Internal Crack Parameters

Designation	x	d	l	Designation	x	d	l
I1	10	0.25	10	**I21**	3	0.25	10
I2	10	0.25	5	**I22**	3	0.25	5
I3	10	0.25	2.5	**I23**	3	0.25	2.5
I4	10	0.5	10	**I24**	3	0.5	10
I5	10	0.5	5	**I25**	3	0.5	5
I6	10	0.5	2.5	**I26**	3	0.5	2.5
I7	10	1	10	**I27**	3	1	10
I8	10	1	5	**I28**	3	1	5
I9	10	1	2.5	**I29**	3	1	2.5
I10	5	0.25	10	**I30**	3	2.5	10
I11	5	0.25	5	**I31**	3	2.5	5
I12	5	0.25	2.5	**I32**	1	0.25	10
I13	5	0.5	10	**I33**	1	0.25	5
I14	5	0.5	5	**I34**	1	0.25	2.5
I15	5	0.5	2.5	**I35**	1	0.5	10
I16	5	1	10	**I36**	1	0.5	5
I17	5	1	5	**I37**	1	0.5	2.5
I18	5	1	2.5	**I38**	1	1	10
I19	5	2.5	10	**I39**	1	1	5
I20	5	2.5	5	**I40**	1	1	2.5

The process discussed in the previous chapter for determining best-fit coefficients was used on each of these cracks. They have been fit to the set of basis functions including the sine functions (Equation 3) only.

After each crack has been analyzed, the data must be transformed into information that will be useful in identifying cracks when the dimensions and location of the crack are not already known. Multi-variable linear regression is used to relate *S, a1, a2, b1, b2, w, c0, c1, c2, c3,* and *c4* to the corresponding *x, d,* and *l* values. The regression is performed using the MVREGRESS function in MATLAB, the code is

attached in Appendix B. The result of the multi variable linear regression is a 11x3 matrix (β_I). When a 1x11 matrix, including the best-fit coefficients for a single subsurface crack is multiplied by β_I, the result is the characteristics and location of the crack as shown in Equation 6.

$$[S \quad a1 \quad a2 \quad b1 \quad b2 \quad w \quad c0 \quad c1 \quad c2 \quad c3 \quad c4]\, x\, \beta_I = \begin{bmatrix} x \\ d \\ l \end{bmatrix} \qquad \text{(Equation 6)}$$

The β_I matrix is:

$$\beta_I = \begin{bmatrix} 100.21 & -14.39 & 43.58 \\ -1.48 & 2.56 & 26.06 \\ 1.43 & -6.90 & -32.55 \\ 0.01 & 0.51 & -0.36 \\ -0.05 & 0.18 & 3.63 \\ -0.001 & 0.08 & 0.003 \\ -5.87 & 21.32 & 118.8 \\ -0.03 & 3.26 & 0.74 \\ -0.20 & -13.02 & -56.41 \\ 0.50 & 11.45 & 35.46 \\ 0.22 & 10.51 & 68.80 \end{bmatrix}$$

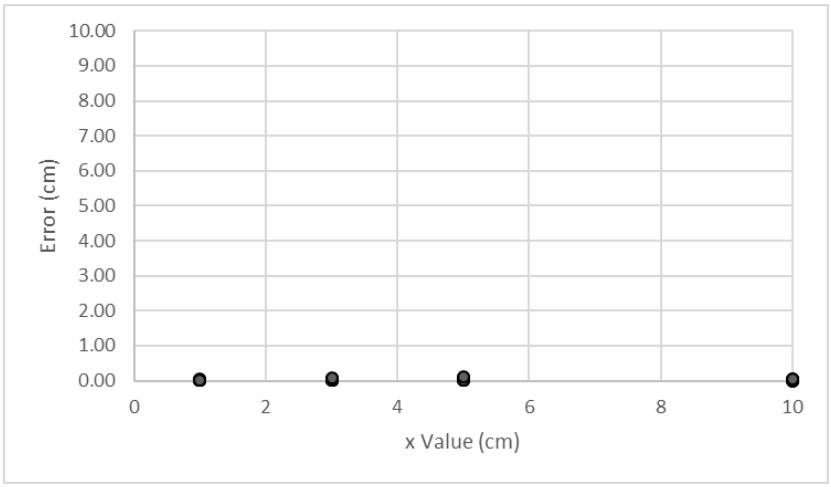
The matrix of best-fit coefficients must be created using the same material and time duration as the data used to create the β matrix for its use to be appropriate in determining crack characteristics. The β matrix is on valid for crack locations and characteristics that fall within the range that was used to create it. For example, the β_I matrix above is only valid for *x* values ranging from 1cm to 10cm, depths ranging from 0.25cm to 2.5cm beneath the surface, and crack lengths ranging from 2.5cm to 10cm.

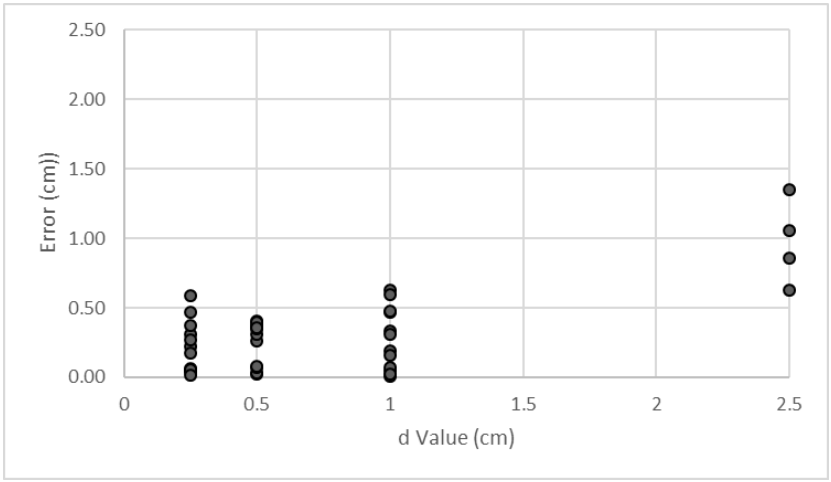
As a method of testing the resultant β_I Matrix, the Equation 3 coefficients are multiplied by the matrix to determine if it accurately calculates the surface crack

parameters. Table 11 below shows the resultant parameters compared to the actual parameters and the error in centimeters for each category. Figure 11 shows a scatter plot for each parameter with the error on the y-axis and the value for the parameter on the x-axis. The y-axis is scaled to the maximum value of the coefficient.

Table 11: Check of Internal Crack β Matrix

	Actual (cm)			MVR Results (cm)			Error (cm)		
	x	d	l	x	d	l	x	d	l
I1	10	0.25	10	10.0	0.47	6.9	0.0	0.22	3.1
I2	10	0.25	5	10.0	0.56	5.1	0.0	0.31	0.1
I3	10	0.25	2.5	10.0	0.84	4.2	0.0	0.59	1.7
I4	10	0.5	10	10.0	0.77	7.1	0.0	0.27	2.9
I5	10	0.5	5	10.0	0.81	5.8	0.0	0.31	0.8
I6	10	0.5	2.5	10.0	0.90	4.8	0.0	0.40	2.3
I7	10	1	10	10.0	0.81	6.5	0.0	0.19	3.5
I8	10	1	5	10.0	0.99	6.1	0.0	0.01	1.1
I9	10	1	2.5	10.1	1.05	6.0	0.1	0.05	3.5
I10	5	0.25	10	4.9	0.07	6.9	0.1	0.18	3.1
I11	5	0.25	5	5.0	0.19	6.1	0.0	0.06	1.1
I12	5	0.25	2.5	5.0	0.30	3.0	0.0	0.05	0.5
I13	5	0.5	10	5.0	0.88	11.4	0.0	0.38	1.4
I14	5	0.5	5	5.1	0.13	3.7	0.1	0.37	1.3
I15	5	0.5	2.5	5.1	0.48	3.7	0.1	0.02	1.2
I16	5	1	10	5.0	0.93	10.6	0.0	0.07	0.6
I17	5	1	5	5.0	0.67	8.0	0.0	0.33	3.0
I18	5	1	2.5	5.1	0.37	2.9	0.1	0.63	0.4
I19	5	2.5	10	5.0	1.44	6.8	0.0	1.06	3.2
I20	5	2.5	5	4.9	1.15	3.3	0.1	1.35	1.7
I21	3	0.25	10	3.0	0.21	8.0	0.0	0.04	2.0
I22	3	0.25	5	3.0	0.31	5.8	0.0	0.06	0.8
I23	3	0.25	2.5	3.0	0.72	3.1	0.0	0.47	0.6
I24	3	0.5	10	3.0	0.53	8.7	0.0	0.03	1.3
I25	3	0.5	5	3.0	0.57	9.0	0.0	0.07	4.0
I26	3	0.5	2.5	3.0	0.90	3.7	0.0	0.40	1.2
I27	3	1	10	3.0	1.31	9.8	0.0	0.31	0.2
I28	3	1	5	3.0	1.16	5.6	0.0	0.16	0.6
I29	3	1	2.5	2.9	0.97	3.2	0.1	0.03	0.7
I30	3	2.5	10	3.1	1.87	6.5	0.1	0.63	3.5
I31	3	2.5	5	3.1	1.65	5.7	0.1	0.85	0.7
I32	1	0.25	10	1.0	0.62	10.2	0.0	0.37	0.2
I33	1	0.25	5	1.0	0.52	7.4	0.0	0.27	2.4
I34	1	0.25	2.5	1.0	0.23	1.4	0.0	0.02	1.1
I35	1	0.5	10	1.0	0.15	7.7	0.0	0.35	2.3
I36	1	0.5	5	1.0	0.42	5.8	0.0	0.08	0.8
I37	1	0.5	2.5	1.0	0.86	1.8	0.0	0.36	0.7
I38	1	1	10	1.0	1.47	6.6	0.0	0.47	3.4
I39	1	1	5	1.0	1.59	7.3	0.0	0.59	2.3
I40	1	1	2.5	1.0	1.48	3.4	0.0	0.48	0.9





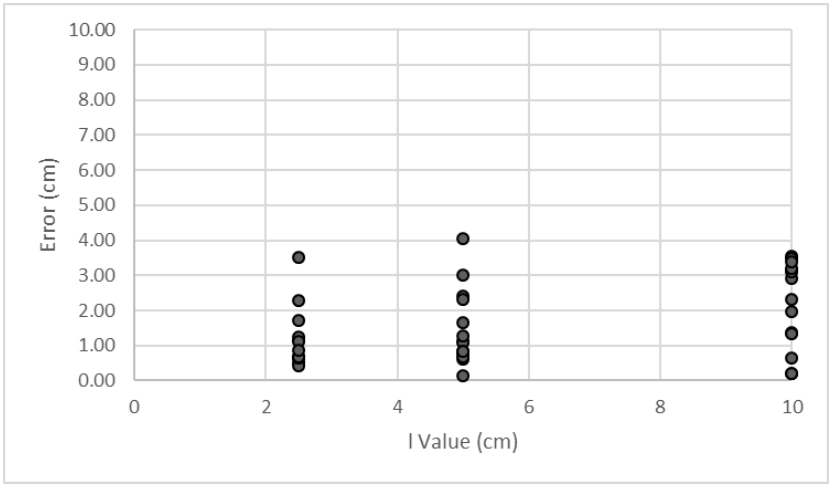


Figure 11: Graphical Representation of Error (a)x Value (b)d Value (c)l Value

It can be concluded from Table 11 and Figure 13 that the β_I matrix is accurate in determining the location of the crack and is less accurate at determining the depth and the length of the crack. Some of the results are very poor at determining the depth and length of the crack and have errors as high as 4cm for length and 1.3cm for depth. The average error in the depth of the crack is 0.32cm. Using Figure 13(b) a trend is visible, the largest error occurs with the 2.5cm crack depth. The average error in depth for 2.5cm deep cracks is 0.97cm, three times the average for all crack depths. The average error for the length is 1.66cm. The lowest average error is that of the location at 0.03cm. This result is reasonable because the *S* value gives an accurate approximation of the location of the crack without the use of the other coefficients.

Chapter 4: Application of Method to Arbitrary Cracks

The purpose of the modeling and numerical analysis in this thesis is to create a framework in which a one-dimensional temperature profile can be analyzed to determine whether a crack is present and to approximate the location and dimensions of that crack. This section will run through this process using four different cracks labeled X1, X2, X3, and X4. The actual parameters of the cracks are assumed to be unknown, but are listed in Table 11 to compare with the results of the analysis.

Table 12: Crack Parameters for X1, X2, X3, and X4

Designation	x (cm)	d (cm)	l (cm)
X1	6	0	4
X2	2	0	7
X3	4	0.7	3
X4	7	0.3	6

For each of the four cracks listed above, a model is created. The temperature resulting from a laser heat source is obtained. In this thesis, this was done analytically by the method discussed in the Crack Modeling section of this thesis, but in real applications this would be done by recording the surface temperature using thermography. The temperature profiles are shifted by a calculated value of x_o as discussed in the Data Analysis section of this paper. The four sets of data points are each fit to the set of basis functions including the sine functions (Equation 3). The coefficient results are shown in Table 12.

Table 13: Equation 3 Coefficients for X1, X2, X3, and X4

	X1	X2	X3	X4
Shift	0.065	0.025	0.040	0.070
a1	5.913	11.908	0.052	-0.158
a2	4.702	11.145	0.114	0.607
b1	36.632	23.043	-0.169	0.441
b2	37.796	25.685	-0.626	-0.358
w	-0.011	-0.019	24.424	30.661
c0	-0.019	-0.029	0.017	0.179
c1	0.002	-0.001	-0.328	-0.447
c2	-0.008	0.015	-0.202	-0.360
c3	0.005	-0.007	-0.098	-0.203
c4	-0.009	-0.010	-0.050	-0.095

After calculating the best fit coefficients, the values for *b1*, *b2*, and *w* are analyzed to determine which cracks are internal and which are surface cracks using *R* values calculated using Equation 4 as discussed in Chapter 3. X1 has an *R* of 74.4, X2 has an *R* of 48.8, X3 has an *R* of -25.2, and X4 has an *R* of -30.6. Since the *R* value for X1 and X2 are positive, they are analyzed to be surface cracks. X1 and X2 are then also fit to Equation 2 to get coefficients that can be multiplied by β_S. Since the *R* value for X3 and X4 is negative, they are analyzed to be subsurface cracks. The Equation 3 coefficients will be multiplied by β_S. Table 13 below shows the coefficients of Equation 2 for X1 and X2.

Table 14: Equation 2 Coefficients for X1 and X2

	X1	X2
Shift	0.0655	0.0251
a1	5.8986	11.8639
a2	4.7177	11.1859
b1	37.2764	23.2662
b2	36.9783	25.405

After multiplying the coefficients for X1 and X2 by β_S and the coefficients for X3 and X4 by β_I, the calculated values for *x*, *d*, and *l* were determined. Table 14 compares the actual values with the calculated values.

Table 15: Calculated Crack Parameters vs. Actual Crack Parameters

	Actual (cm)			**Calculated (cm)**			**Error (cm)**		
Designation	**x**	**d**	**l**	**x**	**d**	**l**	**x**	**d**	**l**
X1	6	0	4	5.9	-	5.5	0.1	-	1.5
X2	2	0	7	2.0	-	8.4	0.0	-	1.4
X3	4	0.7	3	4.0	0.83	3.5	0.0	0.13	0.5
X4	7	0.3	6	7.0	0.61	5.3	0.0	0.31	0.7

The table above shows reasonable results. As discussed earlier, the location of the crack is the easiest to accurately deduce because it accurately approximated by the S value. The x-value of the crack is arguably the most important parameter because it provides the most information on the location on the crack. In practice, the location of the crack can be determined using this process remote monitoring, a local NDT follow up would be conducted.

Chapter 5: Conclusions

This thesis modeled two-dimensional laser point thermography for fifty-two different vertical cracks. The differential between the raw data extracted from cracked models and that of non-cracked models was calculated. This data was then further processed and fit to a set of basis functions that includes peak functions and sine functions. The coefficients were analyzed to determine if the crack is a surface crack or an internal crack. If a crack is determined to be a surface crack, it was also fit to a set of basis functions including only peak functions. The coefficients of the functions were related back to the crack characteristics using multivariable linear regression separately for internal and surface cracks. Lastly, other cracks that were not used in the regression were tested using the framework, in this thesis, all cracks were modeled using finite element software, but in practice this data would be experimental. The results were accurate in determining the horizontal location of the cracks and although they are less accurate at determining other characteristics of the crack, they are still a reasonable starting point.

This research shows potential for using laser point thermography and curve fitting the modified thermal data as a method of locating and determining approximate characteristics of vertical cracks. This method is fairly time consuming and will be best used in areas where there is a larger risk of crack formation, or where cracking is suspected. As discussed in the first section of the paper, similar methodologies are being used to locate small cracks in materials, but the other

techniques do not use a combination of curve fitting and multivariable regression to determine the characteristics of the crack. Two of the most similar methods discussed only detect cracks that are less than one centimeter of the heat source (Li et al. 2010 & Burrows et al. 2007). The framework discussed in this thesis theoretically works for a lot longer distance than that of other work discussed. Future work should include experimental verification of the method to determine its accuracy.

This thesis supports the use of differential laser point thermography for detecting the location, and to some extent the characteristics, of small cracks. For the four unknown cracks tested using the framework, all cracks were detected and correctly characterized as either surface or internal. The error in calculated horizontal location averaged less than 0.1 cm for horizontal locations ranging from 2 cm to 7 cm from the heat source. The error in calculated depth averaged 0.2 cm for depths of 0.3 cm and 0.7 cm. The error in calculated length averaged 1 cm for lengths between 3 cm and 7 cm. Based on these results, this framework has a high level of accuracy in finding cracks and determining their horizontal location, but is less accurate at determining length and depth. This method is not accurate for finding cracks with depths over 2.5 cm. In practice, noise will be introduced into the system and may make it more difficult to locate cracks that are within the detectable range for this thesis. For best results, an experimental baseline should be taken from undamaged locations on the structure that is tested for cracks.

Future work may include inclined cracks. It is not necessary to focus on horizontal cracks as larger scale pulsed thermography covers a more expansive area

in less time and has shown very positive results for finding horizontal cracks and delamination. Cracks at angles should be considered using the framework discussed in this thesis because cracks are not always perfectly perpendicular to the surface. The model created in this thesis was a very simplified, unblemished two-dimensional square. The model can be generalized to three dimensions to determine if a similar framework is an effective method for crack detection and characterization in more realistic scenarios.

The temperature profiles in this thesis are also very dependent on time and the conductivity of the material so separate analyses must be run for different materials or at least different time requirements based on a ratio of the conductivities of the materials. Another similar study may be run in which instead of subtracting an expected temperature curve from the actual curve it should subtract one side of the temperature curve from the other using the location of a laser as the midpoint. This shows if any differences exist between one side of the heat source and the other. This would not be effective for multiple cracks, but could be a simpler way of determining if deformations exist on one side of the laser point.

Appendices

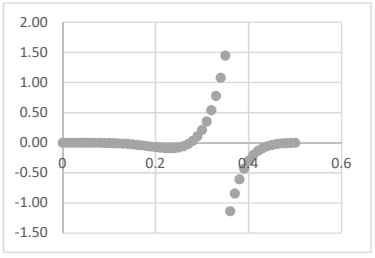
Appendix A: Raw and Calculated Data Spread Sheets for Each Crack

Crack: S1

Distance	Temperature		
	No Crack	Crack	Normalized Difference
0	0.00	0.00	0.00
0.01	0.00	0.00	0.00
0.02	0.00	0.00	0.00
0.03	0.01	0.01	0.00
0.04	0.01	0.01	0.00
0.05	0.02	0.02	0.00
0.06	0.03	0.03	0.00
0.07	0.04	0.04	0.00
0.08	0.06	0.06	0.00
0.09	0.10	0.10	0.00
0.1	0.14	0.14	-0.01
0.11	0.21	0.20	-0.01
0.12	0.29	0.29	-0.01
0.13	0.41	0.40	-0.02
0.14	0.55	0.54	-0.02
0.15	0.73	0.72	-0.03
0.16	0.95	0.93	-0.04
0.17	1.20	1.18	-0.04
0.18	1.47	1.45	-0.05
0.19	1.77	1.73	-0.06
0.2	2.06	2.02	-0.08
0.21	2.34	2.30	-0.08
0.22	2.59	2.54	-0.09
0.23	2.78	2.74	-0.09
0.24	2.91	2.86	-0.09
0.25	2.95	2.91	-0.08
0.26	2.92	2.89	-0.06
0.27	2.80	2.79	-0.02
0.28	2.61	2.63	0.03
0.29	2.37	2.42	0.11
0.3	2.09	2.20	0.21
0.31	1.80	1.97	0.35
0.32	1.50	1.77	0.54
0.33	1.22	1.61	0.78
0.34	0.97	1.51	1.08
0.35	0.75	1.48	1.45
0.36	0.57	0.00	-1.14
0.37	0.42	0.00	-0.84
0.38	0.31	0.00	-0.61
0.39	0.22	0.00	-0.43
0.4	0.15	0.00	-0.30
0.41	0.10	0.00	-0.20
0.42	0.07	0.00	-0.13
0.43	0.04	0.00	-0.09
0.44	0.03	0.00	-0.06
0.45	0.02	0.00	-0.04
0.46	0.01	0.00	-0.02
0.47	0.01	0.00	-0.01
0.48	0.00	0.00	-0.01
0.49	0.00	0.00	0.00
0.5	0.00	0.00	0.00

Shift:	0.356
Shifted Dist.	Norm. Diff.
-0.146	-0.08
-0.136	-0.09
-0.126	-0.09
-0.116	-0.09
-0.106	-0.08
-0.096	-0.06
-0.086	-0.02
-0.076	0.03
-0.066	0.11
-0.056	0.21
-0.046	0.35
-0.036	0.54
-0.026	0.78
-0.016	1.08
-0.006	1.45
0.004	-1.14
0.014	-0.84
0.024	-0.61
0.034	-0.43
0.044	-0.30
0.054	-0.20
0.064	-0.13
0.074	-0.09
0.084	-0.06
0.094	-0.04
0.104	-0.02
0.114	-0.01
0.124	-0.01
0.134	0.00
0.144	0.00

Shift	0.356	0.356
a1	3.475	3.416
a2	2.436	2.500
b1	44.296	49.689
b2	51.797	45.427
w	0.311	
c0	-0.068	
c1	-0.073	
c2	0.455	
c3	0.200	
c4	-0.280	

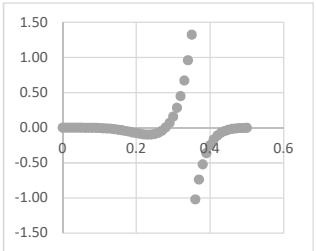


Crack: S2

Distance	Temperature		
	No Crack	Crack	Normalized Difference
0	0.00	0.00	0.00
0.01	0.00	0.00	0.00
0.02	0.00	0.00	0.00
0.03	0.01	0.01	0.00
0.04	0.01	0.01	0.00
0.05	0.02	0.02	0.00
0.06	0.03	0.03	0.00
0.07	0.04	0.04	0.00
0.08	0.06	0.06	0.00
0.09	0.10	0.10	0.00
0.1	0.14	0.14	-0.01
0.11	0.21	0.20	-0.01
0.12	0.29	0.29	-0.01
0.13	0.41	0.40	-0.02
0.14	0.55	0.54	-0.02
0.15	0.73	0.72	-0.03
0.16	0.95	0.93	-0.04
0.17	1.20	1.17	-0.05
0.18	1.47	1.45	-0.06
0.19	1.77	1.73	-0.07
0.2	2.06	2.02	-0.08
0.21	2.34	2.30	-0.09
0.22	2.59	2.54	-0.09
0.23	2.78	2.73	-0.10
0.24	2.91	2.86	-0.10
0.25	2.95	2.91	-0.09
0.26	2.92	2.88	-0.07
0.27	2.80	2.78	-0.04
0.28	2.61	2.61	0.00
0.29	2.37	2.40	0.07
0.3	2.09	2.17	0.16
0.31	1.80	1.94	0.28
0.32	1.50	1.73	0.45
0.33	1.22	1.56	0.67
0.34	0.97	1.45	0.96
0.35	0.75	1.41	1.32
0.36	0.57	0.06	-1.02
0.37	0.42	0.05	-0.74
0.38	0.31	0.04	-0.52
0.39	0.22	0.03	-0.36
0.4	0.15	0.03	-0.25
0.41	0.10	0.02	-0.17
0.42	0.07	0.01	-0.11
0.43	0.04	0.01	-0.07
0.44	0.03	0.01	-0.05
0.45	0.02	0.00	-0.03
0.46	0.01	0.00	-0.02
0.47	0.01	0.00	-0.01
0.48	0.00	0.00	-0.01
0.49	0.00	0.00	0.00
0.5	0.00	0.00	0.00

Shift:	0.356
Shifted Dist.	Norm. Diff.
-0.146	-0.09
-0.136	-0.09
-0.126	-0.10
-0.116	-0.10
-0.106	-0.09
-0.096	-0.07
-0.086	-0.04
-0.076	0.00
-0.066	0.07
-0.056	0.16
-0.046	0.28
-0.036	0.45
-0.026	0.67
-0.016	0.96
-0.006	1.32
0.004	-1.02
0.014	-0.74
0.024	-0.52
0.034	-0.36
0.044	-0.25
0.054	-0.17
0.064	-0.11
0.074	-0.07
0.084	-0.05
0.094	-0.03
0.104	-0.02
0.114	-0.01
0.124	-0.01
0.134	0.00
0.144	0.00

Shift	0.356	0.356
a1	3.202	3.157
a2	2.203	2.244
b1	48.594	53.154
b2	54.461	47.501
w	0.013	
c0	-0.054	
c1	-0.063	
c2	0.060	
c3	0.060	
c4	-0.048	

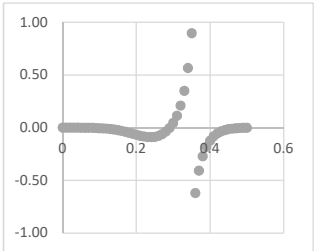


Crack: S3

Distance	Temperature		
	No Crack	Crack	Normalized Difference
0	0.00	0.00	0.00
0.01	0.00	0.00	0.00
0.02	0.00	0.00	0.00
0.03	0.01	0.01	0.00
0.04	0.01	0.01	0.00
0.05	0.02	0.02	0.00
0.06	0.03	0.03	0.00
0.07	0.04	0.04	0.00
0.08	0.06	0.06	0.00
0.09	0.10	0.10	0.00
0.1	0.14	0.14	0.00
0.11	0.21	0.20	-0.01
0.12	0.29	0.29	-0.01
0.13	0.41	0.40	-0.01
0.14	0.55	0.55	-0.02
0.15	0.73	0.72	-0.02
0.16	0.95	0.93	-0.03
0.17	1.20	1.18	-0.04
0.18	1.47	1.45	-0.05
0.19	1.77	1.74	-0.06
0.2	2.06	2.03	-0.07
0.21	2.34	2.30	-0.08
0.22	2.59	2.55	-0.08
0.23	2.78	2.74	-0.09
0.24	2.91	2.86	-0.09
0.25	2.95	2.91	-0.09
0.26	2.92	2.88	-0.08
0.27	2.80	2.77	-0.06
0.28	2.61	2.59	-0.04
0.29	2.37	2.37	0.00
0.3	2.09	2.11	0.04
0.31	1.80	1.85	0.11
0.32	1.50	1.61	0.21
0.33	1.22	1.40	0.35
0.34	0.97	1.25	0.56
0.35	0.75	1.20	0.90
0.36	0.57	0.26	-0.62
0.37	0.42	0.22	-0.41
0.38	0.31	0.17	-0.27
0.39	0.22	0.12	-0.18
0.4	0.15	0.09	-0.12
0.41	0.10	0.06	-0.08
0.42	0.07	0.04	-0.05
0.43	0.04	0.03	-0.04
0.44	0.03	0.02	-0.02
0.45	0.02	0.01	-0.01
0.46	0.01	0.01	-0.01
0.47	0.01	0.00	-0.01
0.48	0.00	0.00	0.00
0.49	0.00	0.00	0.00
0.5	0.00	0.00	0.00

Shift:	0.356
Shifted Dist.	Norm. Diff.
-0.146	-0.08
-0.136	-0.08
-0.126	-0.09
-0.116	-0.09
-0.106	-0.09
-0.096	-0.08
-0.086	-0.06
-0.076	-0.04
-0.066	0.00
-0.056	0.04
-0.046	0.11
-0.036	0.21
-0.026	0.35
-0.016	0.56
-0.006	0.90
0.004	-0.62
0.014	-0.41
0.024	-0.27
0.034	-0.18
0.044	-0.12
0.054	-0.08
0.064	-0.05
0.074	-0.04
0.084	-0.02
0.094	-0.01
0.104	-0.01
0.114	-0.01
0.124	0.00
0.134	0.00
0.144	0.00

Shift	0.356	0.356
a1	2.259	2.235
a2	1.322	1.350
b1	59.699	66.877
b2	65.939	54.113
w	0.000	
c0	-0.045	
c1	0.000	
c2	-0.028	
c3	0.013	
c4	0.004	



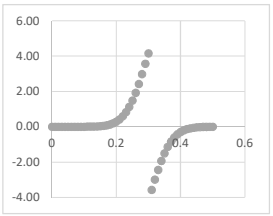
Crack: S4

Distance	Temperature			Shift:	0.305
	No Crack	Crack	Normalized Difference	Shifted Dist.	Norm. Diff.
0	0.00	0.00	0.00		
0.01	0.00	0.00	0.00	-0.145	0.05
0.02	0.00	0.00	0.00	-0.135	0.08
0.03	0.01	0.01	0.00	-0.125	0.13
0.04	0.01	0.01	0.00	-0.115	0.19
0.05	0.02	0.02	0.00	-0.105	0.29
0.06	0.03	0.03	0.00	-0.095	0.42
0.07	0.04	0.04	0.00	-0.085	0.59
0.08	0.06	0.07	0.00	-0.075	0.82
0.09	0.10	0.10	0.00	-0.065	1.12
0.1	0.14	0.15	0.00	-0.055	1.48
0.11	0.21	0.21	0.00	-0.045	1.92
0.12	0.29	0.30	0.01	-0.035	2.42
0.13	0.41	0.41	0.01	-0.025	2.97
0.14	0.55	0.56	0.02	-0.015	3.56
0.15	0.73	0.75	0.03	-0.005	4.15
0.16	0.95	0.97	0.05	0.005	-3.58
0.17	1.20	1.24	0.08	0.015	-3.00
0.18	1.47	1.54	0.13	0.025	-2.44
0.19	1.77	1.86	0.19	0.035	-1.94
0.2	2.06	2.20	0.29	0.045	-1.50
0.21	2.34	2.55	0.42	0.055	-1.14
0.22	2.59	2.89	0.59	0.065	-0.84
0.23	2.78	3.19	0.82	0.075	-0.61
0.24	2.91	3.47	1.12	0.085	-0.43
0.25	2.95	3.69	1.48	0.095	-0.30
0.26	2.92	3.87	1.92	0.105	-0.20
0.27	2.80	4.01	2.42	0.115	-0.13
0.28	2.61	4.10	2.97	0.125	-0.09
0.29	2.37	4.15	3.56	0.135	-0.06
0.3	2.09	4.17	4.15	0.145	-0.04
0.31	1.80	0.00	-3.58		
0.32	1.50	0.00	-3.00		
0.33	1.22	0.00	-2.44		
0.34	0.97	0.00	-1.94		
0.35	0.75	0.00	-1.50		
0.36	0.57	0.00	-1.14		
0.37	0.42	0.00	-0.84		
0.38	0.31	0.00	-0.61		
0.39	0.22	0.00	-0.43		
0.4	0.15	0.00	-0.30		
0.41	0.10	0.00	-0.20		
0.42	0.07	0.00	-0.13		
0.43	0.04	0.00	-0.09		
0.44	0.03	0.00	-0.06		
0.45	0.02	0.00	-0.04		
0.46	0.01	0.00	-0.02		
0.47	0.01	0.00	-0.01		
0.48	0.00	0.00	-0.01		
0.49	0.00	0.00	0.00		
0.5	0.00	0.00	0.00		

Shift	0.305	0.305
a1	9.268	9.244
a2	7.821	7.844
b1	30.151	30.500
b2	33.369	32.900
w	0.000	
c0	-0.022	
c1	0.000	
c2	-0.005	
c3	-0.004	
c4	-0.004	

With Rad Across Crack

0.00	0.00
0.01	0.00
0.02	0.00
0.03	0.01
0.04	0.01
0.05	0.02
0.06	0.03
0.07	0.04
0.08	0.07
0.09	0.10
0.10	0.15
0.11	0.21
0.12	0.30
0.13	0.41
0.14	0.56
0.15	0.75
0.16	0.97
0.17	1.24
0.18	1.54
0.19	1.86
0.20	2.20
0.21	2.55
0.22	2.88
0.23	3.19
0.24	3.46
0.25	3.69
0.26	3.87
0.27	4.00
0.28	4.09
0.29	4.14
0.30	4.15
0.31	0.01
0.32	0.01
0.33	0.01
0.34	0.01
0.35	0.01
0.36	0.00
0.37	0.00
0.38	0.00
0.39	0.00
0.40	0.00
0.41	0.00
0.42	0.00
0.43	0.00
0.44	0.00
0.45	0.00
0.46	0.00
0.47	0.00
0.48	0.00
0.49	0.00
0.50	0.00

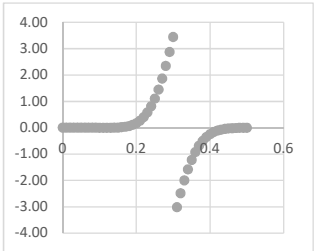


Crack: S5

Distance	Temperature		
	No Crack	Crack	Normalized Difference
0	0.00	0.00	0.00
0.01	0.00	0.00	0.00
0.02	0.00	0.00	0.00
0.03	0.01	0.01	0.00
0.04	0.01	0.01	0.00
0.05	0.02	0.02	0.00
0.06	0.03	0.03	0.00
0.07	0.04	0.04	0.00
0.08	0.06	0.06	0.00
0.09	0.10	0.10	0.00
0.1	0.14	0.14	0.00
0.11	0.21	0.21	0.00
0.12	0.29	0.29	0.00
0.13	0.41	0.41	0.00
0.14	0.55	0.55	0.00
0.15	0.73	0.74	0.01
0.16	0.95	0.96	0.02
0.17	1.20	1.21	0.03
0.18	1.47	1.50	0.06
0.19	1.77	1.82	0.11
0.2	2.06	2.15	0.17
0.21	2.34	2.48	0.27
0.22	2.59	2.79	0.40
0.23	2.78	3.07	0.58
0.24	2.91	3.31	0.81
0.25	2.95	3.50	1.10
0.26	2.92	3.64	1.45
0.27	2.80	3.73	1.86
0.28	2.61	3.78	2.34
0.29	2.37	3.80	2.87
0.3	2.09	3.81	3.44
0.31	1.80	0.28	-3.02
0.32	1.50	0.26	-2.49
0.33	1.22	0.22	-2.01
0.34	0.97	0.18	-1.58
0.35	0.75	0.14	-1.23
0.36	0.57	0.11	-0.93
0.37	0.42	0.08	-0.69
0.38	0.31	0.05	-0.50
0.39	0.22	0.04	-0.36
0.4	0.15	0.03	-0.25
0.41	0.10	0.02	-0.17
0.42	0.07	0.01	-0.11
0.43	0.04	0.01	-0.07
0.44	0.03	0.00	-0.05
0.45	0.02	0.00	-0.03
0.46	0.01	0.00	-0.02
0.47	0.01	0.00	-0.01
0.48	0.00	0.00	-0.01
0.49	0.00	0.00	0.00
0.5	0.00	0.00	0.00

Shift:	0.305
Shifted Dist.	Norm. Diff.
-0.145	0.02
-0.135	0.03
-0.125	0.06
-0.115	0.11
-0.105	0.17
-0.095	0.27
-0.085	0.40
-0.075	0.58
-0.065	0.81
-0.055	1.10
-0.045	1.45
-0.035	1.86
-0.025	2.34
-0.015	2.87
-0.005	3.44
0.005	-3.02
0.015	-2.49
0.025	-2.01
0.035	-1.58
0.045	-1.23
0.055	-0.93
0.065	-0.69
0.075	-0.50
0.085	-0.36
0.095	-0.25
0.105	-0.17
0.115	-0.11
0.125	-0.07
0.135	-0.05
0.145	-0.03

Shift	0.305	0.305
a1	7.673	7.647
a2	6.546	6.572
b1	32.408	32.972
b2	34.078	33.387
w	-0.015	
c0	-0.026	
c1	0.018	
c2	-0.004	
c3	-0.010	
c4	-0.002	

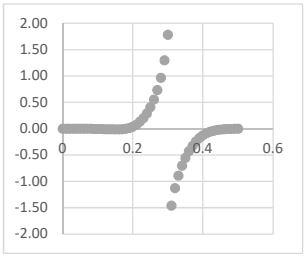


Crack: S6

Distance	Temperature		
	No Crack	Crack	Normalized Difference
0	0.00	0.00	0.00
0.01	0.00	0.00	0.00
0.02	0.00	0.00	0.00
0.03	0.01	0.01	0.00
0.04	0.01	0.01	0.00
0.05	0.02	0.02	0.00
0.06	0.03	0.03	0.00
0.07	0.04	0.04	0.00
0.08	0.06	0.06	0.00
0.09	0.10	0.10	0.00
0.1	0.14	0.14	0.00
0.11	0.21	0.21	-0.01
0.12	0.29	0.29	-0.01
0.13	0.41	0.40	-0.01
0.14	0.55	0.55	-0.01
0.15	0.73	0.73	-0.01
0.16	0.95	0.94	-0.01
0.17	1.20	1.19	-0.01
0.18	1.47	1.47	0.00
0.19	1.77	1.77	0.02
0.2	2.06	2.08	0.04
0.21	2.34	2.38	0.08
0.22	2.59	2.65	0.13
0.23	2.78	2.88	0.20
0.24	2.91	3.05	0.29
0.25	2.95	3.16	0.41
0.26	2.92	3.19	0.55
0.27	2.80	3.16	0.73
0.28	2.61	3.09	0.97
0.29	2.37	3.02	1.30
0.3	2.09	2.98	1.78
0.31	1.80	1.06	-1.46
0.32	1.50	0.94	-1.13
0.33	1.22	0.78	-0.89
0.34	0.97	0.62	-0.70
0.35	0.75	0.48	-0.55
0.36	0.57	0.36	-0.43
0.37	0.42	0.26	-0.32
0.38	0.31	0.19	-0.24
0.39	0.22	0.13	-0.17
0.4	0.15	0.09	-0.12
0.41	0.10	0.06	-0.09
0.42	0.07	0.04	-0.06
0.43	0.04	0.02	-0.04
0.44	0.03	0.02	-0.03
0.45	0.02	0.01	-0.02
0.46	0.01	0.01	-0.01
0.47	0.01	0.00	-0.01
0.48	0.00	0.00	0.00
0.49	0.00	0.00	0.00
0.5	0.00	0.00	0.00

Shift:	0.305
Shifted Dist.	**Norm. Diff.**
-0.145	-0.01
-0.135	-0.01
-0.125	0.00
-0.115	0.02
-0.105	0.04
-0.095	0.08
-0.085	0.13
-0.075	0.20
-0.065	0.29
-0.055	0.41
-0.045	0.55
-0.035	0.73
-0.025	0.97
-0.015	1.30
-0.005	1.78
0.005	-1.46
0.015	-1.13
0.025	-0.89
0.035	-0.70
0.045	-0.55
0.055	-0.43
0.065	-0.32
0.075	-0.24
0.085	-0.17
0.095	-0.12
0.105	-0.09
0.115	-0.06
0.125	-0.04
0.135	-0.03
0.145	-0.02

Shift	0.305	0.305
a1	3.880	3.876
a2	3.058	3.065
b1	39.868	40.382
b2	34.663	34.150
w	-0.012	
c0	-0.008	
c1	0.004	
c2	-0.006	
c3	-0.006	
c4	-0.001	

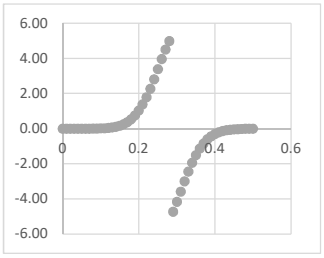


Crack: S7

Distance	Temperature		
	No Crack	Crack	Normalized Difference
0	0.00	0.00	0.00
0.01	0.00	0.00	0.00
0.02	0.00	0.00	0.00
0.03	0.01	0.01	0.00
0.04	0.01	0.01	0.00
0.05	0.02	0.02	0.00
0.06	0.03	0.03	0.00
0.07	0.04	0.04	0.00
0.08	0.06	0.07	0.01
0.09	0.10	0.10	0.01
0.1	0.14	0.15	0.02
0.11	0.21	0.22	0.03
0.12	0.29	0.32	0.04
0.13	0.41	0.44	0.07
0.14	0.55	0.61	0.11
0.15	0.73	0.82	0.17
0.16	0.95	1.08	0.25
0.17	1.20	1.38	0.37
0.18	1.47	1.74	0.54
0.19	1.77	2.14	0.75
0.2	2.06	2.58	1.03
0.21	2.34	3.03	1.38
0.22	2.59	3.48	1.79
0.23	2.78	3.92	2.28
0.24	2.91	4.31	2.81
0.25	2.95	4.65	3.38
0.26	2.92	4.90	3.96
0.27	2.80	5.05	4.51
0.28	2.61	5.11	4.99
0.29	2.37	0.01	-4.72
0.3	2.09	0.01	-4.17
0.31	1.80	0.01	-3.58
0.32	1.50	0.00	-2.99
0.33	1.22	0.00	-2.44
0.34	0.97	0.00	-1.94
0.35	0.75	0.00	-1.50
0.36	0.57	0.00	-1.14
0.37	0.42	0.00	-0.84
0.38	0.31	0.00	-0.61
0.39	0.22	0.00	-0.43
0.4	0.15	0.00	-0.30
0.41	0.10	0.00	-0.20
0.42	0.07	0.00	-0.14
0.43	0.04	0.00	-0.09
0.44	0.03	0.00	-0.06
0.45	0.02	0.00	-0.04
0.46	0.01	0.00	-0.02
0.47	0.01	0.00	-0.01
0.48	0.00	0.00	-0.01
0.49	0.00	0.00	0.00
0.5	0.00	0.00	0.00

Shift:	0.285
Shifted Dist.	**Norm. Diff.**
-0.145	0.11
-0.135	0.17
-0.125	0.25
-0.115	0.37
-0.105	0.54
-0.095	0.75
-0.085	1.03
-0.075	1.38
-0.065	1.79
-0.055	2.28
-0.045	2.81
-0.035	3.38
-0.025	3.96
-0.015	4.51
-0.005	4.99
0.005	-4.72
0.015	-4.17
0.025	-3.58
0.035	-2.99
0.045	-2.44
0.055	-1.94
0.065	-1.50
0.075	-1.14
0.085	-0.84
0.095	-0.61
0.105	-0.43
0.115	-0.30
0.125	-0.20
0.135	-0.14
0.145	-0.09

Shift	0.285	0.285
a1	11.123	11.235
a2	10.164	10.493
b1	23.130	26.147
b2	26.126	27.934
w	0.416	
c0	-0.077	
c1	-1.017	
c2	0.984	
c3	-1.252	
c4	1.927	

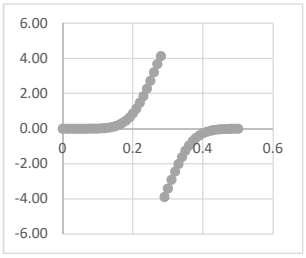


Crack: S8

Distance	Temperature		
	No Crack	Crack	Normalized Difference
0	0.00	0.00	0.00
0.01	0.00	0.00	0.00
0.02	0.00	0.00	0.00
0.03	0.01	0.01	0.00
0.04	0.01	0.01	0.00
0.05	0.02	0.02	0.00
0.06	0.03	0.03	0.00
0.07	0.04	0.04	0.00
0.08	0.06	0.07	0.00
0.09	0.10	0.10	0.01
0.1	0.14	0.15	0.01
0.11	0.21	0.22	0.02
0.12	0.29	0.31	0.04
0.13	0.41	0.44	0.06
0.14	0.55	0.60	0.10
0.15	0.73	0.81	0.15
0.16	0.95	1.06	0.22
0.17	1.20	1.36	0.32
0.18	1.47	1.70	0.46
0.19	1.77	2.08	0.63
0.2	2.06	2.49	0.86
0.21	2.34	2.91	1.14
0.22	2.59	3.32	1.47
0.23	2.78	3.71	1.85
0.24	2.91	4.05	2.28
0.25	2.95	4.32	2.73
0.26	2.92	4.52	3.21
0.27	2.80	4.64	3.68
0.28	2.61	4.68	4.14
0.29	2.37	0.43	-3.88
0.3	2.09	0.39	-3.40
0.31	1.80	0.34	-2.92
0.32	1.50	0.28	-2.45
0.33	1.22	0.22	-2.01
0.34	0.97	0.17	-1.61
0.35	0.75	0.12	-1.26
0.36	0.57	0.09	-0.96
0.37	0.42	0.06	-0.72
0.38	0.31	0.04	-0.52
0.39	0.22	0.03	-0.37
0.4	0.15	0.02	-0.26
0.41	0.10	0.01	-0.18
0.42	0.07	0.01	-0.12
0.43	0.04	0.00	-0.08
0.44	0.03	0.00	-0.05
0.45	0.02	0.00	-0.03
0.46	0.01	0.00	-0.02
0.47	0.01	0.00	-0.01
0.48	0.00	0.00	-0.01
0.49	0.00	0.00	0.00
0.5	0.00	0.00	0.00

Shift:	0.285
Shifted Dist.	**Norm. Diff.**
-0.165	0.04
-0.155	0.06
-0.145	0.10
-0.135	0.15
-0.125	0.22
-0.115	0.32
-0.105	0.46
-0.095	0.63
-0.085	0.86
-0.075	1.14
-0.065	1.47
-0.055	1.85
-0.045	2.28
-0.035	2.73
-0.025	3.21
-0.015	3.68
-0.005	4.14
0.005	-3.88
0.015	-3.40
0.025	-2.92
0.035	-2.45
0.045	-2.01
0.055	-1.61
0.065	-1.26
0.075	-0.96
0.085	-0.72
0.095	-0.52
0.105	-0.37
0.115	-0.26
0.125	-0.18

Shift	0.285	0.285
a1	8.921	9.217
a2	8.446	8.534
b1	24.186	26.262
b2	24.931	27.430
w	-0.634	
c0	0.034	
c1	0.493	
c2	0.951	
c3	-0.436	
c4	-0.864	

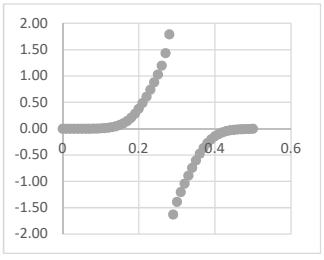


Crack: S9

Distance	Temperature		
	No Crack	Crack	Normalized Difference
0	0.00	0.00	0.00
0.01	0.00	0.00	0.00
0.02	0.00	0.00	0.00
0.03	0.01	0.01	0.00
0.04	0.01	0.01	0.00
0.05	0.02	0.02	0.00
0.06	0.03	0.03	0.00
0.07	0.04	0.04	0.00
0.08	0.06	0.07	0.00
0.09	0.10	0.10	0.00
0.1	0.14	0.15	0.01
0.11	0.21	0.21	0.01
0.12	0.29	0.30	0.02
0.13	0.41	0.42	0.03
0.14	0.55	0.58	0.05
0.15	0.73	0.77	0.07
0.16	0.95	1.00	0.10
0.17	1.20	1.27	0.15
0.18	1.47	1.58	0.21
0.19	1.77	1.91	0.29
0.2	2.06	2.25	0.38
0.21	2.34	2.59	0.49
0.22	2.59	2.89	0.61
0.23	2.78	3.15	0.74
0.24	2.91	3.35	0.88
0.25	2.95	3.47	1.03
0.26	2.92	3.51	1.20
0.27	2.80	3.51	1.43
0.28	2.61	3.51	1.79
0.29	2.37	1.55	-1.63
0.3	2.09	1.40	-1.39
0.31	1.80	1.19	-1.20
0.32	1.50	0.98	-1.04
0.33	1.22	0.78	-0.89
0.34	0.97	0.60	-0.74
0.35	0.75	0.45	-0.60
0.36	0.57	0.33	-0.47
0.37	0.42	0.24	-0.36
0.38	0.31	0.17	-0.27
0.39	0.22	0.12	-0.20
0.4	0.15	0.08	-0.14
0.41	0.10	0.05	-0.10
0.42	0.07	0.03	-0.07
0.43	0.04	0.02	-0.05
0.44	0.03	0.01	-0.03
0.45	0.02	0.01	-0.02
0.46	0.01	0.01	-0.01
0.47	0.01	0.00	-0.01
0.48	0.00	0.00	0.00
0.49	0.00	0.00	0.00
0.5	0.00	0.00	0.00

Shift:	0.285
Shifted Dist.	**Norm. Diff.**
-0.145	0.05
-0.135	0.07
-0.125	0.10
-0.115	0.15
-0.105	0.21
-0.095	0.29
-0.085	0.38
-0.075	0.49
-0.065	0.61
-0.055	0.74
-0.045	0.88
-0.035	1.03
-0.025	1.20
-0.015	1.43
-0.005	1.79
0.005	-1.63
0.015	-1.39
0.025	-1.20
0.035	-1.04
0.045	-0.89
0.055	-0.74
0.065	-0.60
0.075	-0.47
0.085	-0.36
0.095	-0.27
0.105	-0.20
0.115	-0.14
0.125	-0.10
0.135	-0.07
0.145	-0.05

Shift	0.285	0.285
a1	3.677	3.701
a2	3.512	3.485
b1	26.834	26.168
b2	24.656	25.278
w	-0.077	
c0	0.020	
c1	0.024	
c2	0.024	
c3	-0.010	
c4	-0.017	

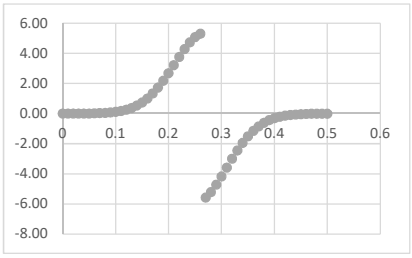


Crack: S10

Distance	Temperature		
	No Crack	Crack	Normalized Difference
0	0.00	0.00	0.00
0.01	0.00	0.00	0.00
0.02	0.00	0.01	0.00
0.03	0.01	0.01	0.00
0.04	0.01	0.01	0.01
0.05	0.02	0.02	0.01
0.06	0.03	0.04	0.02
0.07	0.04	0.06	0.03
0.08	0.06	0.09	0.05
0.09	0.10	0.14	0.08
0.1	0.14	0.20	0.12
0.11	0.21	0.30	0.18
0.12	0.29	0.43	0.26
0.13	0.41	0.60	0.38
0.14	0.55	0.82	0.54
0.15	0.73	1.11	0.74
0.16	0.95	1.45	1.01
0.17	1.20	1.87	1.34
0.18	1.47	2.34	1.73
0.19	1.77	2.86	2.19
0.2	2.06	3.41	2.69
0.21	2.34	3.96	3.23
0.22	2.59	4.47	3.77
0.23	2.78	4.92	4.28
0.24	2.91	5.27	4.73
0.25	2.95	5.50	5.09
0.26	2.92	5.57	5.31
0.27	2.80	0.01	-5.58
0.28	2.61	0.01	-5.21
0.29	2.37	0.01	-4.72
0.3	2.09	0.01	-4.17
0.31	1.80	0.00	-3.58
0.32	1.50	0.00	-3.00
0.33	1.22	0.00	-2.44
0.34	0.97	0.00	-1.94
0.35	0.75	0.00	-1.50
0.36	0.57	0.00	-1.14
0.37	0.42	0.00	-0.84
0.38	0.31	0.00	-0.61
0.39	0.22	0.00	-0.43
0.4	0.15	0.00	-0.30
0.41	0.10	0.00	-0.20
0.42	0.07	0.00	-0.14
0.43	0.04	0.00	-0.09
0.44	0.03	0.00	-0.06
0.45	0.02	0.00	-0.04
0.46	0.01	0.00	-0.02
0.47	0.01	0.00	-0.01
0.48	0.00	0.00	-0.01
0.49	0.00	0.00	0.00
0.5	0.00	0.00	0.00

Shift:	0.265
Shifted Dist.	**Norm. Diff.**
-0.145	0.26
-0.135	0.38
-0.125	0.54
-0.115	0.74
-0.105	1.01
-0.095	1.34
-0.085	1.73
-0.075	2.19
-0.065	2.69
-0.055	3.23
-0.045	3.77
-0.035	4.28
-0.025	4.73
-0.015	5.09
-0.005	5.31
0.005	-5.58
0.015	-5.21
0.025	-4.72
0.035	-4.17
0.045	-3.58
0.055	-3.00
0.065	-2.44
0.075	-1.94
0.085	-1.50
0.095	-1.14
0.105	-0.84
0.115	-0.61
0.125	-0.43
0.135	-0.30
0.145	-0.20

Shift	0.265	0.265
a1	12.273	12.271
a2	12.717	12.718
b1	21.109	21.114
b2	23.149	23.144
w	0.004	
c0	-0.001	
c1	-0.032	
c2	-0.011	
c3	0.010	
c4	0.000	

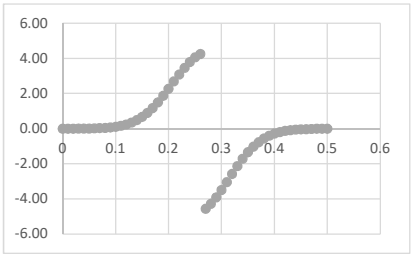


Crack: S11

Distance	Temperature		
	No Crack	Crack	Normalized Difference
0	0.00	0.00	0.00
0.01	0.00	0.00	0.00
0.02	0.00	0.01	0.00
0.03	0.01	0.01	0.00
0.04	0.01	0.01	0.01
0.05	0.02	0.02	0.01
0.06	0.03	0.04	0.02
0.07	0.04	0.06	0.03
0.08	0.06	0.09	0.05
0.09	0.10	0.13	0.07
0.1	0.14	0.20	0.11
0.11	0.21	0.29	0.16
0.12	0.29	0.41	0.24
0.13	0.41	0.58	0.34
0.14	0.55	0.80	0.49
0.15	0.73	1.07	0.67
0.16	0.95	1.40	0.90
0.17	1.20	1.79	1.18
0.18	1.47	2.22	1.50
0.19	1.77	2.70	1.87
0.2	2.06	3.20	2.27
0.21	2.34	3.68	2.69
0.22	2.59	4.13	3.09
0.23	2.78	4.51	3.47
0.24	2.91	4.80	3.79
0.25	2.95	4.98	4.06
0.26	2.92	5.04	4.26
0.27	2.80	0.52	-4.56
0.28	2.61	0.48	-4.27
0.29	2.37	0.41	-3.91
0.3	2.09	0.34	-3.49
0.31	1.80	0.28	-3.04
0.32	1.50	0.21	-2.58
0.33	1.22	0.16	-2.13
0.34	0.97	0.12	-1.71
0.35	0.75	0.08	-1.34
0.36	0.57	0.06	-1.03
0.37	0.42	0.04	-0.77
0.38	0.31	0.03	-0.56
0.39	0.22	0.02	-0.40
0.4	0.15	0.01	-0.28
0.41	0.10	0.01	-0.19
0.42	0.07	0.00	-0.13
0.43	0.04	0.00	-0.08
0.44	0.03	0.00	-0.05
0.45	0.02	0.00	-0.03
0.46	0.01	0.00	-0.02
0.47	0.01	0.00	-0.01
0.48	0.00	0.00	-0.01
0.49	0.00	0.00	0.00
0.5	0.00	0.00	0.00

Shift:	0.265
Shifted Dist.	**Norm. Diff.**
-0.145	0.24
-0.135	0.34
-0.125	0.49
-0.115	0.67
-0.105	0.90
-0.095	1.18
-0.085	1.50
-0.075	1.87
-0.065	2.27
-0.055	2.69
-0.045	3.09
-0.035	3.47
-0.025	3.79
-0.015	4.06
-0.005	4.26
0.005	-4.56
0.015	-4.27
0.025	-3.91
0.035	-3.49
0.045	-3.04
0.055	-2.58
0.065	-2.13
0.075	-1.71
0.085	-1.34
0.095	-1.03
0.105	-0.77
0.115	-0.56
0.125	-0.40
0.135	-0.28
0.145	-0.19

Shift	0.265	0.265
a1	9.764	9.782
a2	10.419	10.402
b1	20.294	20.216
b2	22.074	22.160
w	-0.005	
c0	0.011	
c1	-0.022	
c2	-0.013	
c3	0.011	
c4	-0.004	

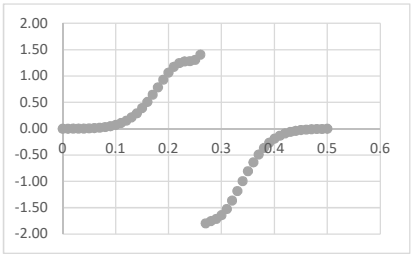


Crack: S12

Distance	Temperature		
	No Crack	Crack	Normalized Difference
0	0.00	0.00	0.00
0.01	0.00	0.00	0.00
0.02	0.00	0.00	0.00
0.03	0.01	0.01	0.00
0.04	0.01	0.01	0.00
0.05	0.02	0.02	0.01
0.06	0.03	0.03	0.01
0.07	0.04	0.05	0.02
0.08	0.06	0.08	0.03
0.09	0.10	0.12	0.05
0.1	0.14	0.18	0.07
0.11	0.21	0.26	0.11
0.12	0.29	0.37	0.15
0.13	0.41	0.52	0.21
0.14	0.55	0.70	0.29
0.15	0.73	0.93	0.39
0.16	0.95	1.20	0.51
0.17	1.20	1.52	0.64
0.18	1.47	1.87	0.79
0.19	1.77	2.23	0.93
0.2	2.06	2.59	1.06
0.21	2.34	2.93	1.17
0.22	2.59	3.21	1.24
0.23	2.78	3.42	1.28
0.24	2.91	3.55	1.28
0.25	2.95	3.60	1.30
0.26	2.92	3.62	1.40
0.27	2.80	1.90	-1.80
0.28	2.61	1.73	-1.75
0.29	2.37	1.51	-1.71
0.3	2.09	1.27	-1.64
0.31	1.80	1.03	-1.52
0.32	1.50	0.82	-1.36
0.33	1.22	0.63	-1.18
0.34	0.97	0.48	-0.99
0.35	0.75	0.35	-0.81
0.36	0.57	0.25	-0.64
0.37	0.42	0.18	-0.49
0.38	0.31	0.12	-0.37
0.39	0.22	0.08	-0.27
0.4	0.15	0.05	-0.19
0.41	0.10	0.04	-0.13
0.42	0.07	0.02	-0.09
0.43	0.04	0.01	-0.06
0.44	0.03	0.01	-0.04
0.45	0.02	0.01	-0.03
0.46	0.01	0.00	-0.02
0.47	0.01	0.00	-0.01
0.48	0.00	0.00	-0.01
0.49	0.00	0.00	0.00
0.5	0.00	0.00	0.00

Shift:	0.264
Shifted Dist.	**Norm. Diff.**
-0.144	0.15
-0.134	0.21
-0.124	0.29
-0.114	0.39
-0.104	0.51
-0.094	0.64
-0.084	0.79
-0.074	0.93
-0.064	1.06
-0.054	1.17
-0.044	1.24
-0.034	1.28
-0.024	1.28
-0.014	1.30
-0.004	1.40
0.006	-1.80
0.016	-1.75
0.026	-1.71
0.036	-1.64
0.046	-1.52
0.056	-1.36
0.066	-1.18
0.076	-0.99
0.086	-0.81
0.096	-0.64
0.106	-0.49
0.116	-0.37
0.126	-0.27
0.136	-0.19
0.146	-0.13

Shift	0.264	0.264
a1	3.075	3.234
a2	4.462	4.312
b1	16.190	15.064
b2	16.718	17.705
w	-0.001	
c0	0.082	
c1	0.013	
c2	-0.042	
c3	0.031	
c4	-0.007	

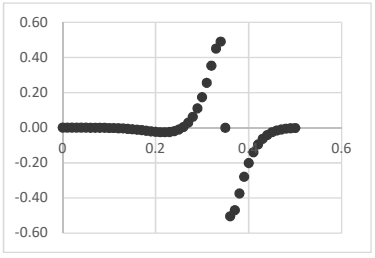


Crack: I1

Distance	Temperature		
	No Crack	Crack	Normalized Difference
0	0.00	0.00	0.00
0.01	0.00	0.00	0.00
0.02	0.00	0.00	0.00
0.03	0.01	0.01	0.00
0.04	0.01	0.01	0.00
0.05	0.02	0.02	0.00
0.06	0.03	0.03	0.00
0.07	0.04	0.04	0.00
0.08	0.06	0.06	0.00
0.09	0.10	0.10	0.00
0.1	0.14	0.14	0.00
0.11	0.21	0.21	0.00
0.12	0.29	0.29	0.00
0.13	0.41	0.41	-0.01
0.14	0.55	0.55	-0.01
0.15	0.73	0.73	-0.01
0.16	0.95	0.94	-0.01
0.17	1.20	1.19	-0.01
0.18	1.47	1.46	-0.02
0.19	1.77	1.76	-0.02
0.2	2.06	2.05	-0.02
0.21	2.34	2.33	-0.03
0.22	2.59	2.58	-0.03
0.23	2.78	2.77	-0.02
0.24	2.91	2.90	-0.02
0.25	2.95	2.95	-0.01
0.26	2.92	2.92	0.00
0.27	2.80	2.81	0.03
0.28	2.61	2.64	0.06
0.29	2.37	2.42	0.11
0.3	2.09	2.18	0.17
0.31	1.80	1.92	0.26
0.32	1.50	1.68	0.35
0.33	1.22	1.45	0.45
0.34	0.97	1.22	0.49
0.35	0.75	0.75	0.00
0.36	0.57	0.32	-0.51
0.37	0.42	0.19	-0.47
0.38	0.31	0.12	-0.37
0.39	0.22	0.08	-0.28
0.4	0.15	0.05	-0.20
0.41	0.10	0.03	-0.14
0.42	0.07	0.02	-0.10
0.43	0.04	0.01	-0.06
0.44	0.03	0.01	-0.04
0.45	0.02	0.00	-0.03
0.46	0.01	0.00	-0.02
0.47	0.01	0.00	-0.01
0.48	0.00	0.00	-0.01
0.49	0.00	0.00	0.00
0.5	0.00	0.00	0.00

Shift:	0.350
Shifted Dist.	Norm. Diff.
-0.140	-0.03
-0.130	-0.03
-0.120	-0.02
-0.110	-0.02
-0.100	-0.01
-0.090	0.00
-0.080	0.03
-0.070	0.06
-0.060	0.11
-0.050	0.17
-0.040	0.26
-0.030	0.35
-0.020	0.45
-0.010	0.49
0.000	0.00
0.010	-0.51
0.020	-0.47
0.030	-0.37
0.040	-0.28
0.050	-0.20
0.060	-0.14
0.070	-0.10
0.080	-0.06
0.090	-0.04
0.100	-0.03
0.110	-0.02
0.120	-0.01
0.130	-0.01
0.140	0.00
0.150	0.00

Shift	0.35
a1	0.13
a2	0.07
b1	0.04
b2	0.31
w	32.26
c0	-0.02
c1	-0.23
c2	-0.19
c3	-0.13
c4	-0.05

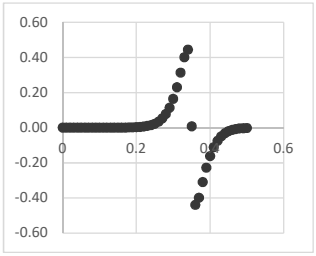


Crack: I2

Distance	Temperature		
	No Crack	Crack	Normalized Difference
0	0.00	0.00	0.00
0.01	0.00	0.00	0.00
0.02	0.00	0.00	0.00
0.03	0.01	0.01	0.00
0.04	0.01	0.01	0.00
0.05	0.02	0.02	0.00
0.06	0.03	0.03	0.00
0.07	0.04	0.04	0.00
0.08	0.06	0.06	0.00
0.09	0.10	0.10	0.00
0.1	0.14	0.14	0.00
0.11	0.21	0.21	0.00
0.12	0.29	0.30	0.00
0.13	0.41	0.41	0.00
0.14	0.55	0.55	0.00
0.15	0.73	0.73	0.00
0.16	0.95	0.95	0.00
0.17	1.20	1.20	0.00
0.18	1.47	1.47	0.00
0.19	1.77	1.77	0.00
0.2	2.06	2.06	0.00
0.21	2.34	2.34	0.00
0.22	2.59	2.59	0.01
0.23	2.78	2.79	0.01
0.24	2.91	2.91	0.01
0.25	2.95	2.96	0.02
0.26	2.92	2.93	0.03
0.27	2.80	2.82	0.05
0.28	2.61	2.65	0.08
0.29	2.37	2.42	0.11
0.3	2.09	2.17	0.16
0.31	1.80	1.91	0.23
0.32	1.50	1.66	0.31
0.33	1.22	1.42	0.40
0.34	0.97	1.19	0.44
0.35	0.75	0.76	0.01
0.36	0.57	0.35	-0.44
0.37	0.42	0.22	-0.40
0.38	0.31	0.15	-0.31
0.39	0.22	0.10	-0.23
0.4	0.15	0.07	-0.16
0.41	0.10	0.05	-0.11
0.42	0.07	0.03	-0.08
0.43	0.04	0.02	-0.05
0.44	0.03	0.01	-0.03
0.45	0.02	0.01	-0.02
0.46	0.01	0.00	-0.01
0.47	0.01	0.00	-0.01
0.48	0.00	0.00	0.00
0.49	0.00	0.00	0.00
0.5	0.00	0.00	0.00

Shift:	0.350
Shifted Dist.	Norm. Diff.
-0.140	0.00
-0.130	0.01
-0.120	0.01
-0.110	0.01
-0.100	0.02
-0.090	0.03
-0.080	0.05
-0.070	0.08
-0.060	0.11
-0.050	0.16
-0.040	0.23
-0.030	0.31
-0.020	0.40
-0.010	0.44
0.000	0.01
0.010	-0.44
0.020	-0.40
0.030	-0.31
0.040	-0.23
0.050	-0.16
0.060	-0.11
0.070	-0.08
0.080	-0.05
0.090	-0.03
0.100	-0.02
0.110	-0.01
0.120	-0.01
0.130	0.00
0.140	0.00
0.150	0.00

Shift	0.350
a1	0.063
a2	0.138
b1	0.105
b2	-0.013
w	32.353
c0	0.017
c1	-0.182
c2	-0.167
c3	-0.110
c4	-0.055

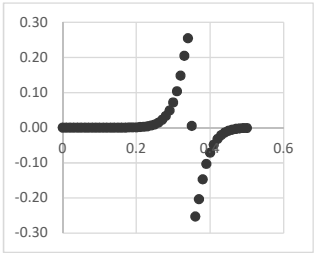


Crack: I3

Distance	Temperature		
	No Crack	Crack	Normalized Difference
0	0.00	0.00	0.00
0.01	0.00	0.00	0.00
0.02	0.00	0.00	0.00
0.03	0.01	0.01	0.00
0.04	0.01	0.01	0.00
0.05	0.02	0.02	0.00
0.06	0.03	0.03	0.00
0.07	0.04	0.04	0.00
0.08	0.06	0.06	0.00
0.09	0.10	0.10	0.00
0.1	0.14	0.14	0.00
0.11	0.21	0.21	0.00
0.12	0.29	0.30	0.00
0.13	0.41	0.41	0.00
0.14	0.55	0.55	0.00
0.15	0.73	0.73	0.00
0.16	0.95	0.95	0.00
0.17	1.20	1.20	0.00
0.18	1.47	1.47	0.00
0.19	1.77	1.77	0.00
0.2	2.06	2.06	0.00
0.21	2.34	2.34	0.00
0.22	2.59	2.59	0.00
0.23	2.78	2.78	0.00
0.24	2.91	2.91	0.01
0.25	2.95	2.96	0.01
0.26	2.92	2.92	0.01
0.27	2.80	2.81	0.02
0.28	2.61	2.63	0.03
0.29	2.37	2.39	0.05
0.3	2.09	2.13	0.07
0.31	1.80	1.85	0.10
0.32	1.50	1.58	0.15
0.33	1.22	1.33	0.20
0.34	0.97	1.10	0.25
0.35	0.75	0.76	0.01
0.36	0.57	0.44	-0.25
0.37	0.42	0.32	-0.20
0.38	0.31	0.23	-0.15
0.39	0.22	0.16	-0.10
0.4	0.15	0.11	-0.07
0.41	0.10	0.08	-0.05
0.42	0.07	0.05	-0.03
0.43	0.04	0.03	-0.02
0.44	0.03	0.02	-0.01
0.45	0.02	0.01	-0.01
0.46	0.01	0.01	-0.01
0.47	0.01	0.01	0.00
0.48	0.00	0.00	0.00
0.49	0.00	0.00	0.00
0.5	0.00	0.00	0.00

Shift:	0.350
Shifted Dist.	Norm. Diff.
-0.140	0.00
-0.130	0.00
-0.120	0.00
-0.110	0.01
-0.100	0.01
-0.090	0.01
-0.080	0.02
-0.070	0.03
-0.060	0.05
-0.050	0.07
-0.040	0.10
-0.030	0.15
-0.020	0.20
-0.010	0.25
0.000	0.01
0.010	-0.25
0.020	-0.20
0.030	-0.15
0.040	-0.10
0.050	-0.07
0.060	-0.05
0.070	-0.03
0.080	-0.02
0.090	-0.01
0.100	-0.01
0.110	-0.01
0.120	0.00
0.130	0.00
0.140	0.00
0.150	0.00

Shift	0.350
a1	0.069
a2	0.030
b1	0.137
b2	0.043
w	33.104
c0	-0.011
c1	-0.089
c2	-0.088
c3	-0.064
c4	-0.036

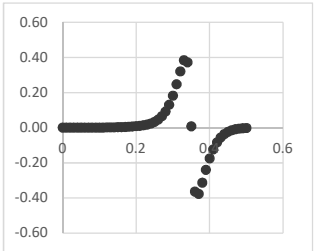


Crack: I4

Distance	Temperature		
	No Crack	Crack	Normalized Difference
0	0.00	0.00	0.00
0.01	0.00	0.00	0.00
0.02	0.00	0.00	0.00
0.03	0.01	0.01	0.00
0.04	0.01	0.01	0.00
0.05	0.02	0.02	0.00
0.06	0.03	0.03	0.00
0.07	0.04	0.04	0.00
0.08	0.06	0.06	0.00
0.09	0.10	0.10	0.00
0.1	0.14	0.14	0.00
0.11	0.21	0.21	0.00
0.12	0.29	0.30	0.00
0.13	0.41	0.41	0.00
0.14	0.55	0.56	0.00
0.15	0.73	0.74	0.00
0.16	0.95	0.95	0.00
0.17	1.20	1.20	0.00
0.18	1.47	1.48	0.01
0.19	1.77	1.77	0.01
0.2	2.06	2.07	0.01
0.21	2.34	2.35	0.01
0.22	2.59	2.60	0.01
0.23	2.78	2.79	0.02
0.24	2.91	2.92	0.02
0.25	2.95	2.97	0.03
0.26	2.92	2.94	0.05
0.27	2.80	2.83	0.06
0.28	2.61	2.66	0.09
0.29	2.37	2.43	0.13
0.3	2.09	2.18	0.18
0.31	1.80	1.92	0.25
0.32	1.50	1.66	0.32
0.33	1.22	1.42	0.38
0.34	0.97	1.16	0.37
0.35	0.75	0.76	0.01
0.36	0.57	0.39	-0.36
0.37	0.42	0.23	-0.38
0.38	0.31	0.15	-0.31
0.39	0.22	0.10	-0.24
0.4	0.15	0.06	-0.18
0.41	0.10	0.04	-0.12
0.42	0.07	0.03	-0.08
0.43	0.04	0.02	-0.06
0.44	0.03	0.01	-0.04
0.45	0.02	0.01	-0.02
0.46	0.01	0.00	-0.01
0.47	0.01	0.00	-0.01
0.48	0.00	0.00	-0.01
0.49	0.00	0.00	0.00
0.5	0.00	0.00	0.00

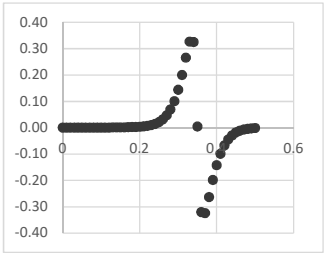
Shift:	0.350
Shifted Dist.	Norm. Diff.
-0.140	0.01
-0.130	0.01
-0.120	0.02
-0.110	0.02
-0.100	0.03
-0.090	0.05
-0.080	0.06
-0.070	0.09
-0.060	0.13
-0.050	0.18
-0.040	0.25
-0.030	0.32
-0.020	0.38
-0.010	0.37
0.000	0.01
0.010	-0.36
0.020	-0.38
0.030	-0.31
0.040	-0.24
0.050	-0.18
0.060	-0.12
0.070	-0.08
0.080	-0.06
0.090	-0.04
0.100	-0.02
0.110	-0.01
0.120	-0.01
0.130	-0.01
0.140	0.00
0.150	0.00

Shift	0.350
a1	0.153
a2	0.040
b1	0.165
b2	0.136
w	31.019
c0	-0.027
c1	-0.180
c2	-0.155
c3	-0.090
c4	-0.039



Crack: I5

Distance	Temperature			Shift:	0.350		
	No Crack	Crack	Normalized Difference	Shifted Dist.	Norm. Diff.	Shift	0.350
0	0.00	0.00	0.00	-0.140	0.00	a1	0.096
0.01	0.00	0.00	0.00	-0.130	0.01	a2	0.067
0.02	0.00	0.00	0.00	-0.120	0.01	b1	0.206
0.03	0.01	0.01	0.00	-0.110	0.01	b2	-0.020
0.04	0.01	0.01	0.00	-0.100	0.02	w	31.554
0.05	0.02	0.02	0.00	-0.090	0.03	c0	-0.008
0.06	0.03	0.03	0.00	-0.080	0.05	c1	-0.151
0.07	0.04	0.04	0.00	-0.070	0.07	c2	-0.133
0.08	0.06	0.06	0.00	-0.060	0.10	c3	-0.081
0.09	0.10	0.10	0.00	-0.050	0.14	c4	-0.035
0.1	0.14	0.14	0.00	-0.040	0.20		
0.11	0.21	0.21	0.00	-0.030	0.27		
0.12	0.29	0.30	0.00	-0.020	0.33		
0.13	0.41	0.41	0.00	-0.010	0.32		
0.14	0.55	0.55	0.00	0.000	0.00		
0.15	0.73	0.73	0.00	0.010	-0.32		
0.16	0.95	0.95	0.00	0.020	-0.32		
0.17	1.20	1.20	0.00	0.030	-0.26		
0.18	1.47	1.47	0.00	0.040	-0.20		
0.19	1.77	1.77	0.00	0.050	-0.14		
0.2	2.06	2.06	0.00	0.060	-0.10		
0.21	2.34	2.34	0.00	0.070	-0.07		
0.22	2.59	2.59	0.01	0.080	-0.04		
0.23	2.78	2.79	0.01	0.090	-0.03		
0.24	2.91	2.91	0.01	0.100	-0.02		
0.25	2.95	2.96	0.02	0.110	-0.01		
0.26	2.92	2.93	0.03	0.120	-0.01		
0.27	2.80	2.82	0.05	0.130	0.00		
0.28	2.61	2.64	0.07	0.140	0.00		
0.29	2.37	2.42	0.10	0.150	0.00		
0.3	2.09	2.16	0.14				
0.31	1.80	1.90	0.20				
0.32	1.50	1.63	0.27				
0.33	1.22	1.39	0.33				
0.34	0.97	1.13	0.32				
0.35	0.75	0.76	0.00				
0.36	0.57	0.41	-0.32				
0.37	0.42	0.26	-0.32				
0.38	0.31	0.17	-0.26				
0.39	0.22	0.12	-0.20				
0.4	0.15	0.08	-0.14				
0.41	0.10	0.05	-0.10				
0.42	0.07	0.03	-0.07				
0.43	0.04	0.02	-0.04				
0.44	0.03	0.01	-0.03				
0.45	0.02	0.01	-0.02				
0.46	0.01	0.01	-0.01				
0.47	0.01	0.00	-0.01				
0.48	0.00	0.00	0.00				
0.49	0.00	0.00	0.00				
0.5	0.00	0.00	0.00				

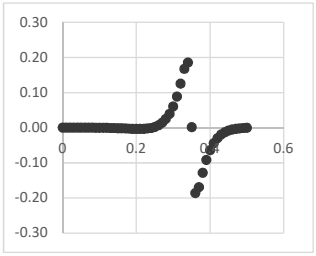


Crack: I6

Distance	Temperature		
	No Crack	Crack	Normalized Difference
0	0.00	0.00	0.00
0.01	0.00	0.00	0.00
0.02	0.00	0.00	0.00
0.03	0.01	0.01	0.00
0.04	0.01	0.01	0.00
0.05	0.02	0.02	0.00
0.06	0.03	0.03	0.00
0.07	0.04	0.04	0.00
0.08	0.06	0.06	0.00
0.09	0.10	0.10	0.00
0.1	0.14	0.14	0.00
0.11	0.21	0.21	0.00
0.12	0.29	0.29	0.00
0.13	0.41	0.41	0.00
0.14	0.55	0.55	0.00
0.15	0.73	0.73	0.00
0.16	0.95	0.95	0.00
0.17	1.20	1.20	0.00
0.18	1.47	1.47	0.00
0.19	1.77	1.76	0.00
0.2	2.06	2.06	0.00
0.21	2.34	2.34	0.00
0.22	2.59	2.59	0.00
0.23	2.78	2.78	0.00
0.24	2.91	2.91	0.00
0.25	2.95	2.95	0.00
0.26	2.92	2.92	0.01
0.27	2.80	2.80	0.01
0.28	2.61	2.62	0.02
0.29	2.37	2.39	0.04
0.3	2.09	2.12	0.06
0.31	1.80	1.84	0.09
0.32	1.50	1.56	0.13
0.33	1.22	1.31	0.17
0.34	0.97	1.07	0.19
0.35	0.75	0.75	0.00
0.36	0.57	0.48	-0.19
0.37	0.42	0.34	-0.17
0.38	0.31	0.24	-0.13
0.39	0.22	0.17	-0.09
0.4	0.15	0.12	-0.06
0.41	0.10	0.08	-0.04
0.42	0.07	0.05	-0.03
0.43	0.04	0.03	-0.02
0.44	0.03	0.02	-0.01
0.45	0.02	0.01	-0.01
0.46	0.01	0.01	-0.01
0.47	0.01	0.01	0.00
0.48	0.00	0.00	0.00
0.49	0.00	0.00	0.00
0.5	0.00	0.00	0.00

Shift:	0.350
Shifted Dist.	Norm. Diff.
-0.140	0.00
-0.130	0.00
-0.120	0.00
-0.110	0.00
-0.100	0.00
-0.090	0.01
-0.080	0.01
-0.070	0.02
-0.060	0.04
-0.050	0.06
-0.040	0.09
-0.030	0.13
-0.020	0.17
-0.010	0.19
0.000	0.00
0.010	-0.19
0.020	-0.17
0.030	-0.13
0.040	-0.09
0.050	-0.06
0.060	-0.04
0.070	-0.03
0.080	-0.02
0.090	-0.01
0.100	-0.01
0.110	-0.01
0.120	0.00
0.130	0.00
0.140	0.00
0.150	0.00

Shift	0.350
a1	0.043
a2	0.029
b1	0.040
b2	0.104
w	32.489
c0	-0.007
c1	-0.076
c2	-0.072
c3	-0.049
c4	-0.024

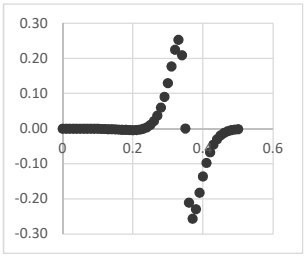


Crack: I7

Distance	Temperature		
	No Crack	Crack	Normalized Difference
0	0.00	0.00	0.00
0.01	0.00	0.00	0.00
0.02	0.00	0.00	0.00
0.03	0.01	0.01	0.00
0.04	0.01	0.01	0.00
0.05	0.02	0.02	0.00
0.06	0.03	0.03	0.00
0.07	0.04	0.04	0.00
0.08	0.06	0.06	0.00
0.09	0.10	0.10	0.00
0.1	0.14	0.14	0.00
0.11	0.21	0.21	0.00
0.12	0.29	0.29	0.00
0.13	0.41	0.41	0.00
0.14	0.55	0.55	0.00
0.15	0.73	0.73	0.00
0.16	0.95	0.95	0.00
0.17	1.20	1.20	0.00
0.18	1.47	1.47	0.00
0.19	1.77	1.76	0.00
0.2	2.06	2.06	0.00
0.21	2.34	2.34	0.00
0.22	2.59	2.59	0.00
0.23	2.78	2.78	0.00
0.24	2.91	2.91	0.00
0.25	2.95	2.96	0.01
0.26	2.92	2.93	0.02
0.27	2.80	2.82	0.04
0.28	2.61	2.64	0.06
0.29	2.37	2.41	0.09
0.3	2.09	2.16	0.13
0.31	1.80	1.88	0.18
0.32	1.50	1.61	0.22
0.33	1.22	1.35	0.25
0.34	0.97	1.08	0.21
0.35	0.75	0.75	0.00
0.36	0.57	0.47	-0.21
0.37	0.42	0.29	-0.26
0.38	0.31	0.19	-0.23
0.39	0.22	0.12	-0.18
0.4	0.15	0.08	-0.14
0.41	0.10	0.05	-0.10
0.42	0.07	0.03	-0.07
0.43	0.04	0.02	-0.05
0.44	0.03	0.01	-0.03
0.45	0.02	0.01	-0.02
0.46	0.01	0.01	-0.01
0.47	0.01	0.00	-0.01
0.48	0.00	0.00	0.00
0.49	0.00	0.00	0.00
0.5	0.00	0.00	0.00

Shift:	0.350
Shifted Dist.	**Norm. Diff.**
-0.140	0.00
-0.130	0.00
-0.120	0.00
-0.110	0.00
-0.100	0.01
-0.090	0.02
-0.080	0.04
-0.070	0.06
-0.060	0.09
-0.050	0.13
-0.040	0.18
-0.030	0.22
-0.020	0.25
-0.010	0.21
0.000	0.00
0.010	-0.21
0.020	-0.26
0.030	-0.23
0.040	-0.18
0.050	-0.14
0.060	-0.10
0.070	-0.07
0.080	-0.05
0.090	-0.03
0.100	-0.02
0.110	-0.01
0.120	-0.01
0.130	0.00
0.140	0.00
0.150	0.00

Shift	0.350
a1	0.074
a2	0.018
b1	-0.011
b2	0.017
w	29.304
c0	-0.017
c1	-0.131
c2	-0.106
c3	-0.053
c4	-0.020

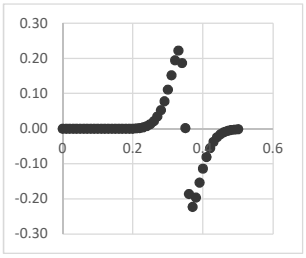


Crack: I8

Distance	Temperature		
	No Crack	Crack	Normalized Difference
0	0.00	0.00	0.00
0.01	0.00	0.00	0.00
0.02	0.00	0.00	0.00
0.03	0.01	0.01	0.00
0.04	0.01	0.01	0.00
0.05	0.02	0.02	0.00
0.06	0.03	0.03	0.00
0.07	0.04	0.04	0.00
0.08	0.06	0.06	0.00
0.09	0.10	0.10	0.00
0.1	0.14	0.14	0.00
0.11	0.21	0.21	0.00
0.12	0.29	0.29	0.00
0.13	0.41	0.41	0.00
0.14	0.55	0.55	0.00
0.15	0.73	0.73	0.00
0.16	0.95	0.95	0.00
0.17	1.20	1.20	0.00
0.18	1.47	1.47	0.00
0.19	1.77	1.77	0.00
0.2	2.06	2.06	0.00
0.21	2.34	2.34	0.00
0.22	2.59	2.59	0.00
0.23	2.78	2.78	0.00
0.24	2.91	2.91	0.01
0.25	2.95	2.96	0.01
0.26	2.92	2.93	0.02
0.27	2.80	2.82	0.03
0.28	2.61	2.64	0.05
0.29	2.37	2.41	0.08
0.3	2.09	2.15	0.11
0.31	1.80	1.87	0.15
0.32	1.50	1.60	0.19
0.33	1.22	1.34	0.22
0.34	0.97	1.07	0.19
0.35	0.75	0.75	0.00
0.36	0.57	0.48	-0.19
0.37	0.42	0.31	-0.22
0.38	0.31	0.21	-0.20
0.39	0.22	0.14	-0.15
0.4	0.15	0.09	-0.11
0.41	0.10	0.06	-0.08
0.42	0.07	0.04	-0.06
0.43	0.04	0.03	-0.04
0.44	0.03	0.02	-0.02
0.45	0.02	0.01	-0.02
0.46	0.01	0.01	-0.01
0.47	0.01	0.00	-0.01
0.48	0.00	0.00	0.00
0.49	0.00	0.00	0.00
0.5	0.00	0.00	0.00

Shift:	0.350
Shifted Dist.	**Norm. Diff.**
-0.140	0.00
-0.130	0.00
-0.120	0.00
-0.110	0.01
-0.100	0.01
-0.090	0.02
-0.080	0.03
-0.070	0.05
-0.060	0.08
-0.050	0.11
-0.040	0.15
-0.030	0.19
-0.020	0.22
-0.010	0.19
0.000	0.00
0.010	-0.19
0.020	-0.22
0.030	-0.20
0.040	-0.15
0.050	-0.11
0.060	-0.08
0.070	-0.06
0.080	-0.04
0.090	-0.02
0.100	-0.02
0.110	-0.01
0.120	-0.01
0.130	0.00
0.140	0.00
0.150	0.00

Shift	0.350
a1	-0.101
a2	0.178
b1	0.085
b2	-0.033
w	29.198
c0	0.068
c1	-0.112
c2	-0.093
c3	-0.047
c4	-0.019

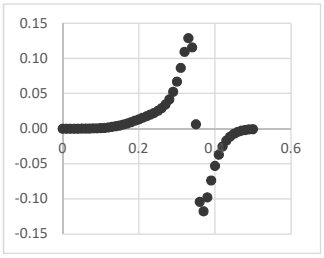


Crack: I9

Distance	Temperature		
	No Crack	Crack	Normalized Difference
0	0.00	0.00	0.00
0.01	0.00	0.00	0.00
0.02	0.00	0.00	0.00
0.03	0.01	0.01	0.00
0.04	0.01	0.01	0.00
0.05	0.02	0.02	0.00
0.06	0.03	0.03	0.00
0.07	0.04	0.04	0.00
0.08	0.06	0.07	0.00
0.09	0.10	0.10	0.00
0.1	0.14	0.14	0.00
0.11	0.21	0.21	0.00
0.12	0.29	0.30	0.00
0.13	0.41	0.41	0.00
0.14	0.55	0.56	0.00
0.15	0.73	0.74	0.00
0.16	0.95	0.95	0.01
0.17	1.20	1.20	0.01
0.18	1.47	1.48	0.01
0.19	1.77	1.77	0.01
0.2	2.06	2.07	0.01
0.21	2.34	2.35	0.02
0.22	2.59	2.60	0.02
0.23	2.78	2.79	0.02
0.24	2.91	2.92	0.02
0.25	2.95	2.97	0.03
0.26	2.92	2.93	0.03
0.27	2.80	2.82	0.03
0.28	2.61	2.63	0.04
0.29	2.37	2.39	0.05
0.3	2.09	2.12	0.07
0.31	1.80	1.84	0.09
0.32	1.50	1.56	0.11
0.33	1.22	1.29	0.13
0.34	0.97	1.03	0.12
0.35	0.75	0.76	0.01
0.36	0.57	0.52	-0.10
0.37	0.42	0.36	-0.12
0.38	0.31	0.26	-0.10
0.39	0.22	0.18	-0.07
0.4	0.15	0.12	-0.05
0.41	0.10	0.08	-0.04
0.42	0.07	0.06	-0.03
0.43	0.04	0.04	-0.02
0.44	0.03	0.02	-0.01
0.45	0.02	0.01	-0.01
0.46	0.01	0.01	0.00
0.47	0.01	0.01	0.00
0.48	0.00	0.00	0.00
0.49	0.00	0.00	0.00
0.5	0.00	0.00	0.00

Shift:	0.351
Shifted Dist.	**Norm. Diff.**
-0.141	0.02
-0.131	0.02
-0.121	0.02
-0.111	0.02
-0.101	0.03
-0.091	0.03
-0.081	0.03
-0.071	0.04
-0.061	0.05
-0.051	0.07
-0.041	0.09
-0.031	0.11
-0.021	0.13
-0.011	0.12
-0.001	0.01
0.009	-0.10
0.019	-0.12
0.029	-0.10
0.039	-0.07
0.049	-0.05
0.059	-0.04
0.069	-0.03
0.079	-0.02
0.089	-0.01
0.099	-0.01
0.109	0.00
0.119	0.00
0.129	0.00
0.139	0.00
0.149	0.00

Shift	0.351
a1	0.055
a2	0.027
b1	0.030
b2	0.006
w	30.705
c0	0.000
c1	-0.055
c2	-0.047
c3	-0.027
c4	-0.010

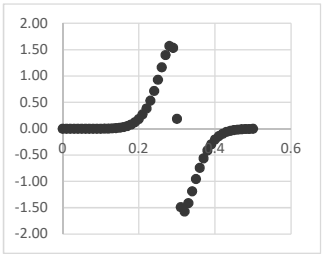


Crack: I10

Distance	Temperature		
	No Crack	Crack	Normalized Difference
0	0.00	0.00	0.00
0.01	0.00	0.00	0.00
0.02	0.00	0.00	0.00
0.03	0.01	0.01	0.00
0.04	0.01	0.01	0.00
0.05	0.02	0.02	0.00
0.06	0.03	0.03	0.00
0.07	0.04	0.04	0.00
0.08	0.06	0.06	0.00
0.09	0.10	0.10	0.00
0.1	0.14	0.14	0.00
0.11	0.21	0.21	0.00
0.12	0.29	0.30	0.00
0.13	0.41	0.41	0.01
0.14	0.55	0.56	0.01
0.15	0.73	0.74	0.02
0.16	0.95	0.96	0.03
0.17	1.20	1.22	0.05
0.18	1.47	1.51	0.08
0.19	1.77	1.83	0.12
0.2	2.06	2.15	0.19
0.21	2.34	2.48	0.27
0.22	2.59	2.78	0.39
0.23	2.78	3.05	0.53
0.24	2.91	3.26	0.72
0.25	2.95	3.42	0.93
0.26	2.92	3.50	1.17
0.27	2.80	3.50	1.40
0.28	2.61	3.40	1.57
0.29	2.37	3.13	1.53
0.3	2.09	2.19	0.19
0.31	1.80	1.05	-1.49
0.32	1.50	0.72	-1.57
0.33	1.22	0.52	-1.41
0.34	0.97	0.38	-1.19
0.35	0.75	0.28	-0.96
0.36	0.57	0.20	-0.74
0.37	0.42	0.14	-0.56
0.38	0.31	0.10	-0.41
0.39	0.22	0.07	-0.30
0.4	0.15	0.05	-0.21
0.41	0.10	0.03	-0.14
0.42	0.07	0.02	-0.10
0.43	0.04	0.01	-0.06
0.44	0.03	0.01	-0.04
0.45	0.02	0.01	-0.03
0.46	0.01	0.00	-0.02
0.47	0.01	0.00	-0.01
0.48	0.00	0.00	-0.01
0.49	0.00	0.00	0.00
0.5	0.00	0.00	0.00

Shift:	0.301
Shifted Dist.	**Norm. Diff.**
-0.141	0.03
-0.131	0.05
-0.121	0.08
-0.111	0.12
-0.101	0.19
-0.091	0.27
-0.081	0.39
-0.071	0.53
-0.061	0.72
-0.051	0.93
-0.041	1.17
-0.031	1.40
-0.021	1.57
-0.011	1.53
-0.001	0.19
0.009	-1.49
0.019	-1.57
0.029	-1.41
0.039	-1.19
0.049	-0.96
0.059	-0.74
0.069	-0.56
0.079	-0.41
0.089	-0.30
0.099	-0.21
0.109	-0.14
0.119	-0.10
0.129	-0.06
0.139	-0.04
0.149	-0.03

Shift	0.301
a1	0.439
a2	1.049
b1	0.568
b2	-0.426
w	20.841
c0	0.168
c1	-0.323
c2	-0.626
c3	-0.255
c4	-0.246

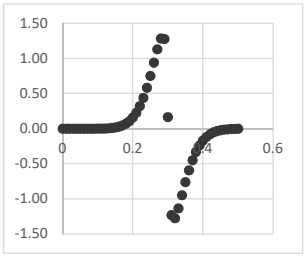


Crack: I11

Distance	Temperature		
	No Crack	Crack	Normalized Difference
0	0.00	0.00	0.00
0.01	0.00	0.00	0.00
0.02	0.00	0.00	0.00
0.03	0.01	0.01	0.00
0.04	0.01	0.01	0.00
0.05	0.02	0.02	0.00
0.06	0.03	0.03	0.00
0.07	0.04	0.04	0.00
0.08	0.06	0.07	0.00
0.09	0.10	0.10	0.00
0.1	0.14	0.14	0.00
0.11	0.21	0.21	0.00
0.12	0.29	0.30	0.00
0.13	0.41	0.41	0.01
0.14	0.55	0.56	0.01
0.15	0.73	0.74	0.02
0.16	0.95	0.96	0.03
0.17	1.20	1.22	0.05
0.18	1.47	1.51	0.07
0.19	1.77	1.82	0.11
0.2	2.06	2.14	0.16
0.21	2.34	2.46	0.23
0.22	2.59	2.75	0.32
0.23	2.78	3.00	0.44
0.24	2.91	3.20	0.58
0.25	2.95	3.33	0.75
0.26	2.92	3.39	0.94
0.27	2.80	3.36	1.13
0.28	2.61	3.25	1.28
0.29	2.37	3.01	1.28
0.3	2.09	2.17	0.17
0.31	1.80	1.18	-1.23
0.32	1.50	0.86	-1.28
0.33	1.22	0.66	-1.13
0.34	0.97	0.50	-0.95
0.35	0.75	0.37	-0.76
0.36	0.57	0.27	-0.59
0.37	0.42	0.20	-0.45
0.38	0.31	0.14	-0.33
0.39	0.22	0.10	-0.24
0.4	0.15	0.07	-0.17
0.41	0.10	0.04	-0.12
0.42	0.07	0.03	-0.08
0.43	0.04	0.02	-0.05
0.44	0.03	0.01	-0.03
0.45	0.02	0.01	-0.02
0.46	0.01	0.00	-0.01
0.47	0.01	0.00	-0.01
0.48	0.00	0.00	-0.01
0.49	0.00	0.00	0.00
0.5	0.00	0.00	0.00

Shift:	0.301
Shifted Dist.	**Norm. Diff.**
-0.141	0.03
-0.131	0.05
-0.121	0.07
-0.111	0.11
-0.101	0.16
-0.091	0.23
-0.081	0.32
-0.071	0.44
-0.061	0.58
-0.051	0.75
-0.041	0.94
-0.031	1.13
-0.021	1.28
-0.011	1.28
-0.001	0.17
0.009	-1.23
0.019	-1.28
0.029	-1.13
0.039	-0.95
0.049	-0.76
0.059	-0.59
0.069	-0.45
0.079	-0.33
0.089	-0.24
0.099	-0.17
0.109	-0.12
0.119	-0.08
0.129	-0.05
0.139	-0.03
0.149	-0.02

Shift	0.301
a1	0.371
a2	0.631
b1	0.641
b2	-0.496
w	31.523
c0	0.063
c1	-0.645
c2	-0.462
c3	-0.257
c4	-0.106

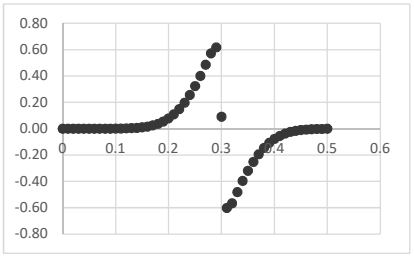


Crack: I12

Distance	Temperature		
	No Crack	Crack	Normalized Difference
0	0.00	0.00	0.00
0.01	0.00	0.00	0.00
0.02	0.00	0.00	0.00
0.03	0.01	0.01	0.00
0.04	0.01	0.01	0.00
0.05	0.02	0.02	0.00
0.06	0.03	0.03	0.00
0.07	0.04	0.04	0.00
0.08	0.06	0.07	0.00
0.09	0.10	0.10	0.00
0.1	0.14	0.14	0.00
0.11	0.21	0.21	0.00
0.12	0.29	0.30	0.00
0.13	0.41	0.41	0.00
0.14	0.55	0.56	0.01
0.15	0.73	0.74	0.01
0.16	0.95	0.96	0.02
0.17	1.20	1.21	0.02
0.18	1.47	1.49	0.04
0.19	1.77	1.79	0.05
0.2	2.06	2.10	0.08
0.21	2.34	2.40	0.11
0.22	2.59	2.66	0.15
0.23	2.78	2.88	0.20
0.24	2.91	3.03	0.26
0.25	2.95	3.11	0.32
0.26	2.92	3.12	0.40
0.27	2.80	3.04	0.49
0.28	2.61	2.90	0.57
0.29	2.37	2.68	0.62
0.3	2.09	2.14	0.09
0.31	1.80	1.49	-0.60
0.32	1.50	1.22	-0.57
0.33	1.22	0.98	-0.48
0.34	0.97	0.77	-0.40
0.35	0.75	0.59	-0.32
0.36	0.57	0.44	-0.25
0.37	0.42	0.32	-0.19
0.38	0.31	0.23	-0.15
0.39	0.22	0.16	-0.11
0.4	0.15	0.11	-0.08
0.41	0.10	0.07	-0.05
0.42	0.07	0.05	-0.04
0.43	0.04	0.03	-0.03
0.44	0.03	0.02	-0.02
0.45	0.02	0.01	-0.01
0.46	0.01	0.01	-0.01
0.47	0.01	0.00	0.00
0.48	0.00	0.00	0.00
0.49	0.00	0.00	0.00
0.5	0.00	0.00	0.00

Shift:	0.301
Shifted Dist.	**Norm. Diff.**
-0.141	0.02
-0.131	0.02
-0.121	0.04
-0.111	0.05
-0.101	0.08
-0.091	0.11
-0.081	0.15
-0.071	0.20
-0.061	0.26
-0.051	0.32
-0.041	0.40
-0.031	0.49
-0.021	0.57
-0.011	0.62
-0.001	0.09
0.009	-0.60
0.019	-0.57
0.029	-0.48
0.039	-0.40
0.049	-0.32
0.059	-0.25
0.069	-0.19
0.079	-0.15
0.089	-0.11
0.099	-0.08
0.109	-0.05
0.119	-0.04
0.129	-0.03
0.139	-0.02
0.149	-0.01

Shift	0.301
a1	0.228
a2	0.192
b1	-0.034
b2	-0.035
w	21.422
c0	-0.005
c1	-0.150
c2	-0.232
c3	-0.111
c4	-0.106

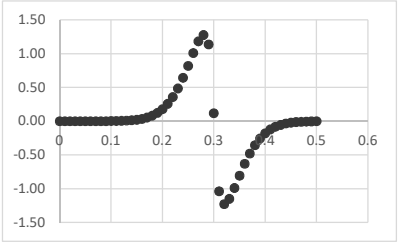


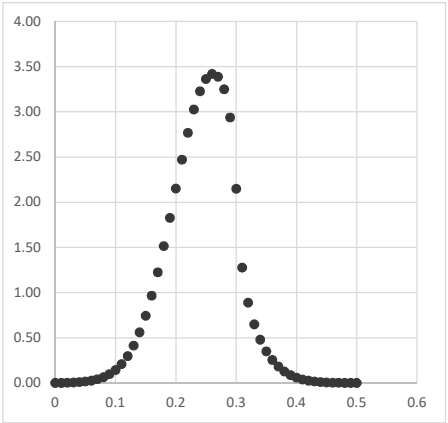
Crack: I13

Distance	Temperature		
	No Crack	Crack	Normalized Difference
0	0.00	0.00	0.00
0.01	0.00	0.00	0.00
0.02	0.00	0.00	0.00
0.03	0.01	0.01	0.00
0.04	0.01	0.01	0.00
0.05	0.02	0.02	0.00
0.06	0.03	0.03	0.00
0.07	0.04	0.04	0.00
0.08	0.06	0.07	0.00
0.09	0.10	0.10	0.00
0.1	0.14	0.14	0.00
0.11	0.21	0.21	0.00
0.12	0.29	0.30	0.00
0.13	0.41	0.41	0.01
0.14	0.55	0.56	0.01
0.15	0.73	0.74	0.02
0.16	0.95	0.97	0.03
0.17	1.20	1.22	0.05
0.18	1.47	1.51	0.08
0.19	1.77	1.83	0.12
0.2	2.06	2.15	0.18
0.21	2.34	2.47	0.26
0.22	2.59	2.77	0.36
0.23	2.78	3.02	0.49
0.24	2.91	3.23	0.64
0.25	2.95	3.36	0.82
0.26	2.92	3.42	1.01
0.27	2.80	3.39	1.18
0.28	2.61	3.25	1.28
0.29	2.37	2.94	1.14
0.3	2.09	2.15	0.12
0.31	1.80	1.28	-1.04
0.32	1.50	0.89	-1.23
0.33	1.22	0.65	-1.15
0.34	0.97	0.48	-0.99
0.35	0.75	0.35	-0.81
0.36	0.57	0.25	-0.63
0.37	0.42	0.18	-0.48
0.38	0.31	0.13	-0.35
0.39	0.22	0.09	-0.25
0.4	0.15	0.06	-0.18
0.41	0.10	0.04	-0.12
0.42	0.07	0.03	-0.08
0.43	0.04	0.02	-0.05
0.44	0.03	0.01	-0.04
0.45	0.02	0.01	-0.02
0.46	0.01	0.00	-0.01
0.47	0.01	0.00	-0.01
0.48	0.00	0.00	-0.01
0.49	0.00	0.00	0.00
0.5	0.00	0.00	0.00

Shift:	0.301
Shifted Dist.	**Norm. Diff.**
-0.141	0.03
-0.131	0.05
-0.121	0.08
-0.111	0.12
-0.101	0.18
-0.091	0.26
-0.081	0.36
-0.071	0.49
-0.061	0.64
-0.051	0.82
-0.041	1.01
-0.031	1.18
-0.021	1.28
-0.011	1.14
-0.001	0.12
0.009	-1.04
0.019	-1.23
0.029	-1.15
0.039	-0.99
0.049	-0.81
0.059	-0.63
0.069	-0.48
0.079	-0.35
0.089	-0.25
0.099	-0.18
0.109	-0.12
0.119	-0.08
0.129	-0.05
0.139	-0.04
0.149	-0.02

Shift	0.301
a1	0.465
a2	0.237
b1	0.815
b2	-0.207
w	28.273
c0	-0.050
c1	-0.691
c2	-0.484
c3	-0.225
c4	-0.104



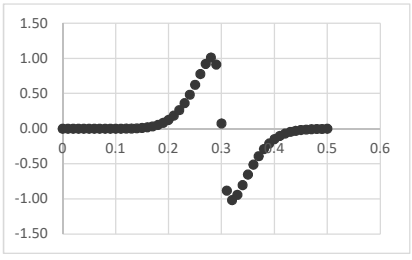


Crack: I14

Distance	Temperature		
	No Crack	Crack	Normalized Difference
0	0.00	0.00	0.00
0.01	0.00	0.00	0.00
0.02	0.00	0.00	0.00
0.03	0.01	0.01	0.00
0.04	0.01	0.01	0.00
0.05	0.02	0.02	0.00
0.06	0.03	0.03	0.00
0.07	0.04	0.04	0.00
0.08	0.06	0.06	0.00
0.09	0.10	0.10	0.00
0.1	0.14	0.14	0.00
0.11	0.21	0.21	0.00
0.12	0.29	0.30	0.00
0.13	0.41	0.41	0.00
0.14	0.55	0.56	0.01
0.15	0.73	0.74	0.01
0.16	0.95	0.96	0.02
0.17	1.20	1.21	0.03
0.18	1.47	1.50	0.05
0.19	1.77	1.81	0.08
0.2	2.06	2.12	0.13
0.21	2.34	2.43	0.18
0.22	2.59	2.72	0.26
0.23	2.78	2.96	0.36
0.24	2.91	3.15	0.48
0.25	2.95	3.27	0.63
0.26	2.92	3.30	0.78
0.27	2.80	3.26	0.92
0.28	2.61	3.12	1.01
0.29	2.37	2.83	0.91
0.3	2.09	2.13	0.08
0.31	1.80	1.36	-0.88
0.32	1.50	0.99	-1.02
0.33	1.22	0.75	-0.94
0.34	0.97	0.57	-0.80
0.35	0.75	0.43	-0.65
0.36	0.57	0.31	-0.51
0.37	0.42	0.23	-0.39
0.38	0.31	0.16	-0.29
0.39	0.22	0.11	-0.21
0.4	0.15	0.08	-0.15
0.41	0.10	0.05	-0.10
0.42	0.07	0.03	-0.07
0.43	0.04	0.02	-0.05
0.44	0.03	0.01	-0.03
0.45	0.02	0.01	-0.02
0.46	0.01	0.01	-0.01
0.47	0.01	0.00	-0.01
0.48	0.00	0.00	0.00
0.49	0.00	0.00	0.00
0.5	0.00	0.00	0.00

Shift:	0.301
Shifted Dist.	**Norm. Diff.**
-0.141	0.02
-0.131	0.03
-0.121	0.05
-0.111	0.08
-0.101	0.13
-0.091	0.18
-0.081	0.26
-0.071	0.36
-0.061	0.48
-0.051	0.63
-0.041	0.78
-0.031	0.92
-0.021	1.01
-0.011	0.91
-0.001	0.08
0.009	-0.88
0.019	-1.02
0.029	-0.94
0.039	-0.80
0.049	-0.65
0.059	-0.51
0.069	-0.39
0.079	-0.29
0.089	-0.21
0.099	-0.15
0.109	-0.10
0.119	-0.07
0.129	-0.05
0.139	-0.03
0.149	-0.02

Shift	0.301
a1	0.450
a2	0.588
b1	0.235
b2	-0.385
w	20.069
c0	0.029
c1	-0.153
c2	-0.430
c3	-0.162
c4	-0.167

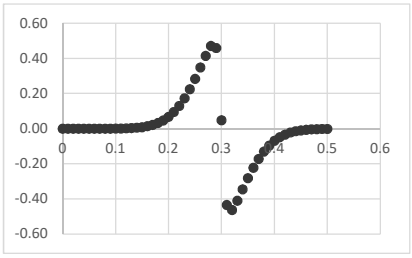


Crack: I15

Distance	Temperature		
	No Crack	Crack	Normalized Difference
0	0.00	0.00	0.00
0.01	0.00	0.00	0.00
0.02	0.00	0.00	0.00
0.03	0.01	0.01	0.00
0.04	0.01	0.01	0.00
0.05	0.02	0.02	0.00
0.06	0.03	0.03	0.00
0.07	0.04	0.04	0.00
0.08	0.06	0.06	0.00
0.09	0.10	0.10	0.00
0.1	0.14	0.14	0.00
0.11	0.21	0.21	0.00
0.12	0.29	0.30	0.00
0.13	0.41	0.41	0.00
0.14	0.55	0.56	0.01
0.15	0.73	0.74	0.01
0.16	0.95	0.96	0.01
0.17	1.20	1.21	0.02
0.18	1.47	1.49	0.03
0.19	1.77	1.79	0.05
0.2	2.06	2.10	0.07
0.21	2.34	2.39	0.09
0.22	2.59	2.65	0.13
0.23	2.78	2.87	0.17
0.24	2.91	3.02	0.22
0.25	2.95	3.09	0.28
0.26	2.92	3.09	0.35
0.27	2.80	3.01	0.42
0.28	2.61	2.85	0.47
0.29	2.37	2.60	0.46
0.3	2.09	2.11	0.05
0.31	1.80	1.58	-0.43
0.32	1.50	1.27	-0.46
0.33	1.22	1.02	-0.41
0.34	0.97	0.80	-0.34
0.35	0.75	0.61	-0.28
0.36	0.57	0.46	-0.22
0.37	0.42	0.34	-0.17
0.38	0.31	0.24	-0.13
0.39	0.22	0.17	-0.10
0.4	0.15	0.12	-0.07
0.41	0.10	0.08	-0.05
0.42	0.07	0.05	-0.03
0.43	0.04	0.03	-0.02
0.44	0.03	0.02	-0.01
0.45	0.02	0.01	-0.01
0.46	0.01	0.01	-0.01
0.47	0.01	0.00	0.00
0.48	0.00	0.00	0.00
0.49	0.00	0.00	0.00
0.5	0.00	0.00	0.00

Shift:	0.301
Shifted Dist.	**Norm. Diff.**
-0.141	0.01
-0.131	0.02
-0.121	0.03
-0.111	0.05
-0.101	0.07
-0.091	0.09
-0.081	0.13
-0.071	0.17
-0.061	0.22
-0.051	0.28
-0.041	0.35
-0.031	0.42
-0.021	0.47
-0.011	0.46
-0.001	0.05
0.009	-0.43
0.019	-0.46
0.029	-0.41
0.039	-0.34
0.049	-0.28
0.059	-0.22
0.069	-0.17
0.079	-0.13
0.089	-0.10
0.099	-0.07
0.109	-0.05
0.119	-0.03
0.129	-0.02
0.139	-0.01
0.149	-0.01

Shift	0.301
a1	0.207
a2	0.179
b1	-0.077
b2	0.029
w	20.844
c0	-0.005
c1	-0.111
c2	-0.192
c3	-0.082
c4	-0.081

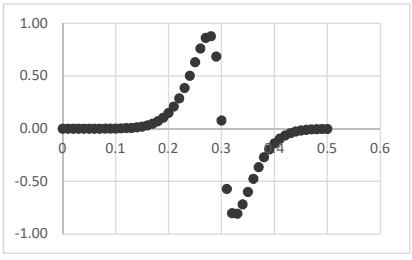


Crack: I16

Distance	Temperature		
	No Crack	Crack	Normalized Difference
0	0.00	0.00	0.00
0.01	0.00	0.00	0.00
0.02	0.00	0.00	0.00
0.03	0.01	0.01	0.00
0.04	0.01	0.01	0.00
0.05	0.02	0.02	0.00
0.06	0.03	0.03	0.00
0.07	0.04	0.04	0.00
0.08	0.06	0.07	0.00
0.09	0.10	0.10	0.00
0.1	0.14	0.14	0.00
0.11	0.21	0.21	0.00
0.12	0.29	0.30	0.01
0.13	0.41	0.41	0.01
0.14	0.55	0.56	0.01
0.15	0.73	0.74	0.02
0.16	0.95	0.96	0.03
0.17	1.20	1.22	0.05
0.18	1.47	1.51	0.07
0.19	1.77	1.82	0.10
0.2	2.06	2.14	0.15
0.21	2.34	2.45	0.21
0.22	2.59	2.73	0.29
0.23	2.78	2.98	0.39
0.24	2.91	3.16	0.50
0.25	2.95	3.27	0.63
0.26	2.92	3.30	0.76
0.27	2.80	3.23	0.86
0.28	2.61	3.05	0.88
0.29	2.37	2.71	0.68
0.3	2.09	2.13	0.08
0.31	1.80	1.51	-0.57
0.32	1.50	1.10	-0.80
0.33	1.22	0.82	-0.81
0.34	0.97	0.61	-0.72
0.35	0.75	0.45	-0.60
0.36	0.57	0.33	-0.48
0.37	0.42	0.24	-0.37
0.38	0.31	0.17	-0.27
0.39	0.22	0.12	-0.20
0.4	0.15	0.08	-0.14
0.41	0.10	0.05	-0.10
0.42	0.07	0.04	-0.06
0.43	0.04	0.02	-0.04
0.44	0.03	0.01	-0.03
0.45	0.02	0.01	-0.02
0.46	0.01	0.01	-0.01
0.47	0.01	0.00	-0.01
0.48	0.00	0.00	0.00
0.49	0.00	0.00	0.00
0.5	0.00	0.00	0.00

Shift:	0.301
Shifted Dist.	**Norm. Diff.**
-0.141	0.03
-0.131	0.05
-0.121	0.07
-0.111	0.10
-0.101	0.15
-0.091	0.21
-0.081	0.29
-0.071	0.39
-0.061	0.50
-0.051	0.63
-0.041	0.76
-0.031	0.86
-0.021	0.88
-0.011	0.68
-0.001	0.08
0.009	-0.57
0.019	-0.80
0.029	-0.81
0.039	-0.72
0.049	-0.60
0.059	-0.48
0.069	-0.37
0.079	-0.27
0.089	-0.20
0.099	-0.14
0.109	-0.10
0.119	-0.06
0.129	-0.04
0.139	-0.03
0.149	-0.02

Shift	0.301
a1	0.261
a2	0.371
b1	-0.231
b2	0.226
w	20.386
c0	0.041
c1	-0.265
c2	-0.373
c3	-0.145
c4	-0.114

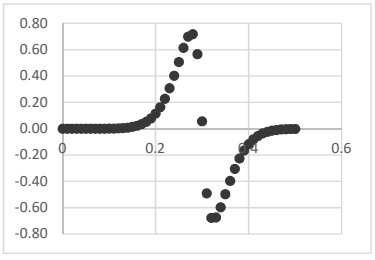


Crack: I17

Distance	Temperature		
	No Crack	Crack	Normalized Difference
0	0.00	0.00	0.00
0.01	0.00	0.00	0.00
0.02	0.00	0.00	0.00
0.03	0.01	0.01	0.00
0.04	0.01	0.01	0.00
0.05	0.02	0.02	0.00
0.06	0.03	0.03	0.00
0.07	0.04	0.04	0.00
0.08	0.06	0.07	0.00
0.09	0.10	0.10	0.00
0.1	0.14	0.14	0.00
0.11	0.21	0.21	0.00
0.12	0.29	0.30	0.00
0.13	0.41	0.41	0.00
0.14	0.55	0.56	0.01
0.15	0.73	0.74	0.01
0.16	0.95	0.96	0.02
0.17	1.20	1.21	0.03
0.18	1.47	1.50	0.05
0.19	1.77	1.81	0.08
0.2	2.06	2.12	0.11
0.21	2.34	2.42	0.16
0.22	2.59	2.70	0.23
0.23	2.78	2.94	0.31
0.24	2.91	3.11	0.40
0.25	2.95	3.21	0.51
0.26	2.92	3.22	0.61
0.27	2.80	3.15	0.70
0.28	2.61	2.97	0.72
0.29	2.37	2.65	0.57
0.3	2.09	2.12	0.06
0.31	1.80	1.55	-0.49
0.32	1.50	1.16	-0.68
0.33	1.22	0.89	-0.67
0.34	0.97	0.67	-0.60
0.35	0.75	0.51	-0.50
0.36	0.57	0.37	-0.40
0.37	0.42	0.27	-0.30
0.38	0.31	0.19	-0.23
0.39	0.22	0.13	-0.16
0.4	0.15	0.09	-0.12
0.41	0.10	0.06	-0.08
0.42	0.07	0.04	-0.05
0.43	0.04	0.03	-0.04
0.44	0.03	0.02	-0.02
0.45	0.02	0.01	-0.02
0.46	0.01	0.01	-0.01
0.47	0.01	0.00	-0.01
0.48	0.00	0.00	0.00
0.49	0.00	0.00	0.00
0.5	0.00	0.00	0.00

Shift:	0.301
Shifted Dist.	Norm. Diff.
-0.141	0.02
-0.131	0.03
-0.121	0.05
-0.111	0.08
-0.101	0.11
-0.091	0.16
-0.081	0.23
-0.071	0.31
-0.061	0.40
-0.051	0.51
-0.041	0.61
-0.031	0.70
-0.021	0.72
-0.011	0.57
-0.001	0.06
0.009	-0.49
0.019	-0.68
0.029	-0.67
0.039	-0.60
0.049	-0.50
0.059	-0.40
0.069	-0.30
0.079	-0.23
0.089	-0.16
0.099	-0.12
0.109	-0.08
0.119	-0.05
0.129	-0.04
0.139	-0.02
0.149	-0.02

Shift	0.301
a1	0.312
a2	0.296
b1	-0.215
b2	0.206
w	20.083
c0	0.000
c1	-0.180
c2	-0.308
c3	-0.115
c4	-0.098

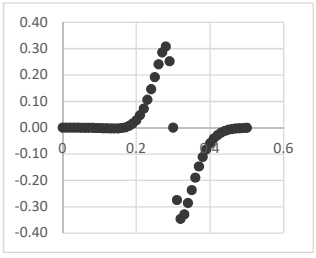


Crack: I18

Distance	Temperature		
	No Crack	Crack	Normalized Difference
0	0.00	0.00	0.00
0.01	0.00	0.00	0.00
0.02	0.00	0.00	0.00
0.03	0.01	0.01	0.00
0.04	0.01	0.01	0.00
0.05	0.02	0.02	0.00
0.06	0.03	0.03	0.00
0.07	0.04	0.04	0.00
0.08	0.06	0.06	0.00
0.09	0.10	0.10	0.00
0.1	0.14	0.14	0.00
0.11	0.21	0.21	0.00
0.12	0.29	0.29	0.00
0.13	0.41	0.41	0.00
0.14	0.55	0.55	0.00
0.15	0.73	0.73	0.00
0.16	0.95	0.95	0.00
0.17	1.20	1.20	0.00
0.18	1.47	1.48	0.01
0.19	1.77	1.77	0.02
0.2	2.06	2.08	0.03
0.21	2.34	2.37	0.05
0.22	2.59	2.62	0.07
0.23	2.78	2.83	0.11
0.24	2.91	2.98	0.15
0.25	2.95	3.05	0.19
0.26	2.92	3.04	0.24
0.27	2.80	2.94	0.29
0.28	2.61	2.76	0.31
0.29	2.37	2.49	0.25
0.3	2.09	2.09	0.00
0.31	1.80	1.66	-0.27
0.32	1.50	1.33	-0.35
0.33	1.22	1.06	-0.33
0.34	0.97	0.83	-0.29
0.35	0.75	0.64	-0.24
0.36	0.57	0.48	-0.19
0.37	0.42	0.35	-0.15
0.38	0.31	0.25	-0.11
0.39	0.22	0.17	-0.08
0.4	0.15	0.12	-0.06
0.41	0.10	0.08	-0.04
0.42	0.07	0.05	-0.03
0.43	0.04	0.03	-0.02
0.44	0.03	0.02	-0.01
0.45	0.02	0.01	-0.01
0.46	0.01	0.01	-0.01
0.47	0.01	0.01	0.00
0.48	0.00	0.00	0.00
0.49	0.00	0.00	0.00
0.5	0.00	0.00	0.00

Shift:	0.300
Shifted Dist.	Norm. Diff.
-0.140	0.00
-0.130	0.00
-0.120	0.01
-0.110	0.02
-0.100	0.03
-0.090	0.05
-0.080	0.07
-0.070	0.11
-0.060	0.15
-0.050	0.19
-0.040	0.24
-0.030	0.29
-0.020	0.31
-0.010	0.25
0.000	0.00
0.010	-0.27
0.020	-0.35
0.030	-0.33
0.040	-0.29
0.050	-0.24
0.060	-0.19
0.070	-0.15
0.080	-0.11
0.090	-0.08
0.100	-0.06
0.110	-0.04
0.120	-0.03
0.130	-0.02
0.140	-0.01
0.150	-0.01

Shift	0.300
a1	0.292
a2	0.187
b1	-0.041
b2	0.297
w	19.238
c0	-0.041
c1	0.001
c2	-0.141
c3	-0.036
c4	-0.054

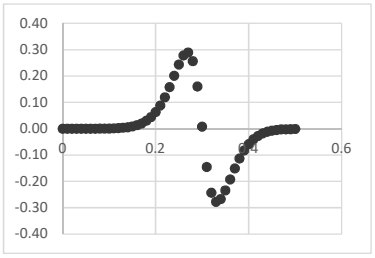


Crack: I19

Distance	Temperature		
	No Crack	Crack	Normalized Difference
0	0.00	0.00	0.00
0.01	0.00	0.00	0.00
0.02	0.00	0.00	0.00
0.03	0.01	0.01	0.00
0.04	0.01	0.01	0.00
0.05	0.02	0.02	0.00
0.06	0.03	0.03	0.00
0.07	0.04	0.04	0.00
0.08	0.06	0.07	0.00
0.09	0.10	0.10	0.00
0.1	0.14	0.14	0.00
0.11	0.21	0.21	0.00
0.12	0.29	0.30	0.00
0.13	0.41	0.41	0.00
0.14	0.55	0.56	0.01
0.15	0.73	0.74	0.01
0.16	0.95	0.96	0.01
0.17	1.20	1.21	0.02
0.18	1.47	1.49	0.03
0.19	1.77	1.79	0.04
0.2	2.06	2.09	0.06
0.21	2.34	2.39	0.09
0.22	2.59	2.65	0.12
0.23	2.78	2.86	0.16
0.24	2.91	3.01	0.20
0.25	2.95	3.07	0.24
0.26	2.92	3.05	0.28
0.27	2.80	2.94	0.29
0.28	2.61	2.74	0.26
0.29	2.37	2.45	0.16
0.3	2.09	2.09	0.01
0.31	1.80	1.72	-0.15
0.32	1.50	1.38	-0.24
0.33	1.22	1.09	-0.28
0.34	0.97	0.84	-0.27
0.35	0.75	0.64	-0.23
0.36	0.57	0.47	-0.19
0.37	0.42	0.35	-0.15
0.38	0.31	0.25	-0.11
0.39	0.22	0.17	-0.08
0.4	0.15	0.12	-0.06
0.41	0.10	0.08	-0.04
0.42	0.07	0.05	-0.03
0.43	0.04	0.04	-0.02
0.44	0.03	0.02	-0.01
0.45	0.02	0.01	-0.01
0.46	0.01	0.01	0.00
0.47	0.01	0.01	0.00
0.48	0.00	0.00	0.00
0.49	0.00	0.00	0.00
0.5	0.00	0.00	0.00

Shift:	0.300
Shifted Dist.	Norm. Diff.
-0.140	0.01
-0.130	0.02
-0.120	0.03
-0.110	0.04
-0.100	0.06
-0.090	0.09
-0.080	0.12
-0.070	0.16
-0.060	0.20
-0.050	0.24
-0.040	0.28
-0.030	0.29
-0.020	0.26
-0.010	0.16
0.000	0.01
0.010	-0.15
0.020	-0.24
0.030	-0.28
0.040	-0.27
0.050	-0.23
0.060	-0.19
0.070	-0.15
0.080	-0.11
0.090	-0.08
0.100	-0.06
0.110	-0.04
0.120	-0.03
0.130	-0.02
0.140	-0.01
0.150	-0.01

Shift	0.300
a1	0.061
a2	-0.005
b1	0.080
b2	0.113
w	22.905
c0	-0.013
c1	-0.183
c2	-0.118
c3	-0.041
c4	-0.016

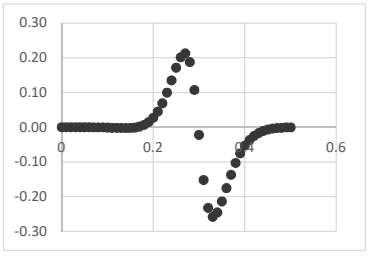


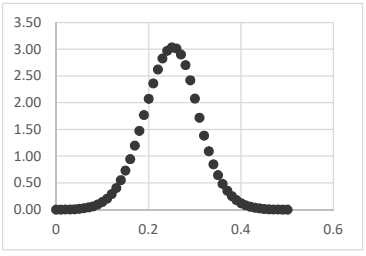
Crack: I20

Distance	Temperature		
	No Crack	Crack	Normalized Difference
0	0.00	0.00	0.00
0.01	0.00	0.00	0.00
0.02	0.00	0.00	0.00
0.03	0.01	0.01	0.00
0.04	0.01	0.01	0.00
0.05	0.02	0.02	0.00
0.06	0.03	0.03	0.00
0.07	0.04	0.04	0.00
0.08	0.06	0.06	0.00
0.09	0.10	0.10	0.00
0.1	0.14	0.14	0.00
0.11	0.21	0.21	0.00
0.12	0.29	0.29	0.00
0.13	0.41	0.41	0.00
0.14	0.55	0.55	0.00
0.15	0.73	0.73	0.00
0.16	0.95	0.95	0.00
0.17	1.20	1.20	0.00
0.18	1.47	1.48	0.01
0.19	1.77	1.77	0.01
0.2	2.06	2.07	0.03
0.21	2.34	2.36	0.04
0.22	2.59	2.62	0.07
0.23	2.78	2.83	0.10
0.24	2.91	2.97	0.13
0.25	2.95	3.04	0.17
0.26	2.92	3.02	0.20
0.27	2.80	2.90	0.21
0.28	2.61	2.70	0.19
0.29	2.37	2.42	0.11
0.3	2.09	2.08	-0.02
0.31	1.80	1.72	-0.15
0.32	1.50	1.39	-0.23
0.33	1.22	1.09	-0.26
0.34	0.97	0.85	-0.25
0.35	0.75	0.65	-0.21
0.36	0.57	0.48	-0.18
0.37	0.42	0.35	-0.14
0.38	0.31	0.25	-0.10
0.39	0.22	0.18	-0.08
0.4	0.15	0.12	-0.05
0.41	0.10	0.08	-0.04
0.42	0.07	0.06	-0.03
0.43	0.04	0.04	-0.02
0.44	0.03	0.02	-0.01
0.45	0.02	0.01	-0.01
0.46	0.01	0.01	0.00
0.47	0.01	0.01	0.00
0.48	0.00	0.00	0.00
0.49	0.00	0.00	0.00
0.5	0.00	0.00	0.00

Shift:	0.298
Shifted Dist.	Norm. Diff.
-0.148	0.00
-0.138	0.00
-0.128	0.00
-0.118	0.01
-0.108	0.01
-0.098	0.03
-0.088	0.04
-0.078	0.07
-0.068	0.10
-0.058	0.13
-0.048	0.17
-0.038	0.20
-0.028	0.21
-0.018	0.19
-0.008	0.11
0.002	-0.02
0.012	-0.15
0.022	-0.23
0.032	-0.26
0.042	-0.25
0.052	-0.21
0.062	-0.18
0.072	-0.14
0.082	-0.10
0.092	-0.08
0.102	-0.05
0.112	-0.04
0.122	-0.03
0.132	-0.02
0.142	-0.01

Shift	0.298
a1	0.013
a2	0.024
b1	0.110
b2	-0.028
w	23.605
c0	-0.013
c1	-0.152
c2	-0.099
c3	-0.034
c4	-0.014



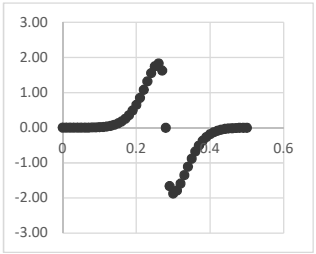


Crack: I21

Distance	Temperature		
	No Crack	Crack	Normalized Difference
0	0.00	0.00	0.00
0.01	0.00	0.00	0.00
0.02	0.00	0.00	0.00
0.03	0.01	0.01	0.00
0.04	0.01	0.01	0.00
0.05	0.02	0.02	0.00
0.06	0.03	0.03	0.00
0.07	0.04	0.04	0.00
0.08	0.06	0.07	0.00
0.09	0.10	0.10	0.01
0.1	0.14	0.15	0.01
0.11	0.21	0.22	0.02
0.12	0.29	0.31	0.03
0.13	0.41	0.43	0.05
0.14	0.55	0.59	0.08
0.15	0.73	0.79	0.12
0.16	0.95	1.04	0.18
0.17	1.20	1.32	0.25
0.18	1.47	1.65	0.36
0.19	1.77	2.01	0.49
0.2	2.06	2.39	0.65
0.21	2.34	2.77	0.85
0.22	2.59	3.13	1.07
0.23	2.78	3.44	1.32
0.24	2.91	3.68	1.55
0.25	2.95	3.82	1.74
0.26	2.92	3.83	1.83
0.27	2.80	3.61	1.62
0.28	2.61	2.61	-0.01
0.29	2.37	1.54	-1.66
0.3	2.09	1.15	-1.87
0.31	1.80	0.90	-1.79
0.32	1.50	0.71	-1.59
0.33	1.22	0.55	-1.35
0.34	0.97	0.42	-1.11
0.35	0.75	0.31	-0.88
0.36	0.57	0.23	-0.68
0.37	0.42	0.17	-0.51
0.38	0.31	0.12	-0.37
0.39	0.22	0.08	-0.27
0.4	0.15	0.06	-0.19
0.41	0.10	0.04	-0.13
0.42	0.07	0.02	-0.09
0.43	0.04	0.02	-0.06
0.44	0.03	0.01	-0.04
0.45	0.02	0.01	-0.02
0.46	0.01	0.00	-0.01
0.47	0.01	0.00	-0.01
0.48	0.00	0.00	-0.01
0.49	0.00	0.00	0.00
0.5	0.00	0.00	0.00

Shift:	0.280
Shifted Dist.	Norm. Diff.
-0.150	0.05
-0.140	0.08
-0.130	0.12
-0.120	0.18
-0.110	0.25
-0.100	0.36
-0.090	0.49
-0.080	0.65
-0.070	0.85
-0.060	1.07
-0.050	1.32
-0.040	1.55
-0.030	1.74
-0.020	1.83
-0.010	1.62
0.000	-0.01
0.010	-1.66
0.020	-1.87
0.030	-1.79
0.040	-1.59
0.050	-1.35
0.060	-1.11
0.070	-0.88
0.080	-0.68
0.090	-0.51
0.100	-0.37
0.110	-0.27
0.120	-0.19
0.130	-0.13
0.140	-0.09

Shift	0.280
a1	1.030
a2	0.949
b1	0.381
b2	-0.286
w	19.876
c0	-0.028
c1	-0.395
c2	-0.806
c3	-0.282
c4	-0.290

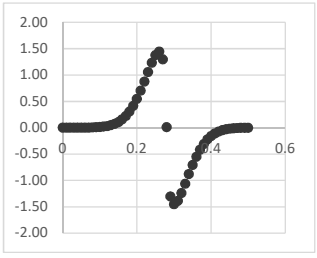


Crack: I22

Distance	Temperature		
	No Crack	Crack	Normalized Difference
0	0.00	0.00	0.00
0.01	0.00	0.00	0.00
0.02	0.00	0.00	0.00
0.03	0.01	0.01	0.00
0.04	0.01	0.01	0.00
0.05	0.02	0.02	0.00
0.06	0.03	0.03	0.00
0.07	0.04	0.04	0.00
0.08	0.06	0.07	0.00
0.09	0.10	0.10	0.01
0.1	0.14	0.15	0.01
0.11	0.21	0.22	0.02
0.12	0.29	0.31	0.03
0.13	0.41	0.43	0.05
0.14	0.55	0.59	0.07
0.15	0.73	0.79	0.11
0.16	0.95	1.03	0.16
0.17	1.20	1.31	0.22
0.18	1.47	1.63	0.31
0.19	1.77	1.97	0.41
0.2	2.06	2.33	0.55
0.21	2.34	2.69	0.70
0.22	2.59	3.03	0.87
0.23	2.78	3.31	1.06
0.24	2.91	3.52	1.23
0.25	2.95	3.64	1.38
0.26	2.92	3.64	1.44
0.27	2.80	3.45	1.30
0.28	2.61	2.61	0.01
0.29	2.37	1.72	-1.30
0.3	2.09	1.36	-1.45
0.31	1.80	1.10	-1.39
0.32	1.50	0.88	-1.24
0.33	1.22	0.69	-1.07
0.34	0.97	0.53	-0.88
0.35	0.75	0.40	-0.71
0.36	0.57	0.29	-0.55
0.37	0.42	0.21	-0.42
0.38	0.31	0.15	-0.31
0.39	0.22	0.10	-0.22
0.4	0.15	0.07	-0.16
0.41	0.10	0.05	-0.11
0.42	0.07	0.03	-0.07
0.43	0.04	0.02	-0.05
0.44	0.03	0.01	-0.03
0.45	0.02	0.01	-0.02
0.46	0.01	0.00	-0.01
0.47	0.01	0.00	-0.01
0.48	0.00	0.00	0.00
0.49	0.00	0.00	0.00
0.5	0.00	0.00	0.00

Shift:	0.280
Shifted Dist.	Norm. Diff.
-0.140	0.07
-0.130	0.11
-0.120	0.16
-0.110	0.22
-0.100	0.31
-0.090	0.41
-0.080	0.55
-0.070	0.70
-0.060	0.87
-0.050	1.06
-0.040	1.23
-0.030	1.38
-0.020	1.44
-0.010	1.30
0.000	0.01
0.010	-1.30
0.020	-1.45
0.030	-1.39
0.040	-1.24
0.050	-1.07
0.060	-0.88
0.070	-0.71
0.080	-0.55
0.090	-0.42
0.100	-0.31
0.110	-0.22
0.120	-0.16
0.130	-0.11
0.140	-0.07
0.150	-0.05

Shift	0.280
a1	0.746
a2	0.786
b1	0.400
b2	-0.802
w	19.940
c0	0.010
c1	-0.338
c2	-0.621
c3	-0.202
c4	-0.220

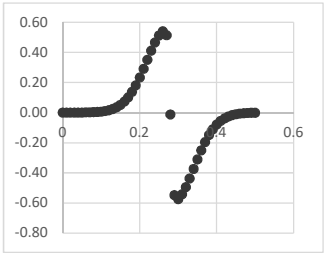


Crack: I23

Distance	Temperature		
	No Crack	Crack	Normalized Difference
0	0.00	0.00	0.00
0.01	0.00	0.00	0.00
0.02	0.00	0.00	0.00
0.03	0.01	0.01	0.00
0.04	0.01	0.01	0.00
0.05	0.02	0.02	0.00
0.06	0.03	0.03	0.00
0.07	0.04	0.04	0.00
0.08	0.06	0.07	0.00
0.09	0.10	0.10	0.00
0.1	0.14	0.15	0.01
0.11	0.21	0.21	0.01
0.12	0.29	0.30	0.02
0.13	0.41	0.42	0.02
0.14	0.55	0.57	0.03
0.15	0.73	0.76	0.05
0.16	0.95	0.99	0.07
0.17	1.20	1.25	0.10
0.18	1.47	1.54	0.14
0.19	1.77	1.86	0.18
0.2	2.06	2.18	0.23
0.21	2.34	2.49	0.29
0.22	2.59	2.76	0.35
0.23	2.78	2.99	0.41
0.24	2.91	3.14	0.47
0.25	2.95	3.21	0.51
0.26	2.92	3.19	0.54
0.27	2.80	3.05	0.51
0.28	2.61	2.60	-0.01
0.29	2.37	2.09	-0.55
0.3	2.09	1.80	-0.57
0.31	1.80	1.52	-0.54
0.32	1.50	1.25	-0.50
0.33	1.22	1.01	-0.44
0.34	0.97	0.79	-0.37
0.35	0.75	0.60	-0.31
0.36	0.57	0.45	-0.25
0.37	0.42	0.32	-0.20
0.38	0.31	0.23	-0.15
0.39	0.22	0.16	-0.11
0.4	0.15	0.11	-0.08
0.41	0.10	0.07	-0.06
0.42	0.07	0.05	-0.04
0.43	0.04	0.03	-0.03
0.44	0.03	0.02	-0.02
0.45	0.02	0.01	-0.01
0.46	0.01	0.01	-0.01
0.47	0.01	0.00	0.00
0.48	0.00	0.00	0.00
0.49	0.00	0.00	0.00
0.5	0.00	0.00	0.00

Shift:	0.280
Shifted Dist.	Norm. Diff.
-0.150	0.02
-0.140	0.03
-0.130	0.05
-0.120	0.07
-0.110	0.10
-0.100	0.14
-0.090	0.18
-0.080	0.23
-0.070	0.29
-0.060	0.35
-0.050	0.41
-0.040	0.47
-0.030	0.51
-0.020	0.54
-0.010	0.51
0.000	-0.01
0.010	-0.55
0.020	-0.57
0.030	-0.54
0.040	-0.50
0.050	-0.44
0.060	-0.37
0.070	-0.31
0.080	-0.25
0.090	-0.20
0.100	-0.15
0.110	-0.11
0.120	-0.08
0.130	-0.06
0.140	-0.04

Shift	0.280
a1	0.194
a2	0.307
b1	0.128
b2	-0.076
w	20.736
c0	0.021
c1	-0.201
c2	-0.231
c3	-0.080
c4	-0.080

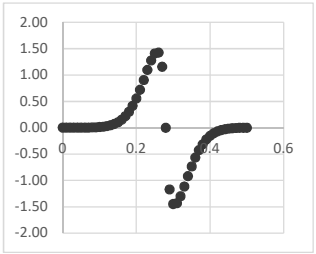


Crack: I24

Distance	Temperature		
	No Crack	Crack	Normalized Difference
0	0.00	0.00	0.00
0.01	0.00	0.00	0.00
0.02	0.00	0.00	0.00
0.03	0.01	0.01	0.00
0.04	0.01	0.01	0.00
0.05	0.02	0.02	0.00
0.06	0.03	0.03	0.00
0.07	0.04	0.04	0.00
0.08	0.06	0.07	0.00
0.09	0.10	0.10	0.01
0.1	0.14	0.15	0.01
0.11	0.21	0.22	0.02
0.12	0.29	0.31	0.03
0.13	0.41	0.43	0.04
0.14	0.55	0.59	0.07
0.15	0.73	0.79	0.10
0.16	0.95	1.02	0.15
0.17	1.20	1.31	0.22
0.18	1.47	1.62	0.30
0.19	1.77	1.97	0.42
0.2	2.06	2.34	0.55
0.21	2.34	2.70	0.72
0.22	2.59	3.04	0.90
0.23	2.78	3.33	1.10
0.24	2.91	3.55	1.28
0.25	2.95	3.66	1.41
0.26	2.92	3.63	1.43
0.27	2.80	3.38	1.16
0.28	2.61	2.61	0.00
0.29	2.37	1.78	-1.18
0.3	2.09	1.37	-1.45
0.31	1.80	1.08	-1.43
0.32	1.50	0.85	-1.30
0.33	1.22	0.67	-1.12
0.34	0.97	0.51	-0.92
0.35	0.75	0.39	-0.73
0.36	0.57	0.29	-0.57
0.37	0.42	0.21	-0.43
0.38	0.31	0.15	-0.31
0.39	0.22	0.10	-0.22
0.4	0.15	0.07	-0.16
0.41	0.10	0.05	-0.11
0.42	0.07	0.03	-0.07
0.43	0.04	0.02	-0.05
0.44	0.03	0.01	-0.03
0.45	0.02	0.01	-0.02
0.46	0.01	0.01	-0.01
0.47	0.01	0.00	-0.01
0.48	0.00	0.00	0.00
0.49	0.00	0.00	0.00
0.5	0.00	0.00	0.00

Shift:	0.280
Shifted Dist.	Norm. Diff.
-0.150	0.04
-0.140	0.07
-0.130	0.10
-0.120	0.15
-0.110	0.22
-0.100	0.30
-0.090	0.42
-0.080	0.55
-0.070	0.72
-0.060	0.90
-0.050	1.10
-0.040	1.28
-0.030	1.41
-0.020	1.43
-0.010	1.16
0.000	0.00
0.010	-1.18
0.020	-1.45
0.030	-1.43
0.040	-1.30
0.050	-1.12
0.060	-0.92
0.070	-0.73
0.080	-0.57
0.090	-0.43
0.100	-0.31
0.110	-0.22
0.120	-0.16
0.130	-0.11
0.140	-0.07

Shift	0.280
a1	0.610
a2	1.044
b1	0.250
b2	-0.285
w	19.545
c0	0.098
c1	-0.297
c2	-0.639
c3	-0.201
c4	-0.201

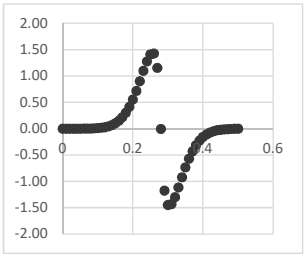


Crack: I25

Distance	Temperature		
	No Crack	Crack	Normalized Difference
0	0.00	0.00	0.00
0.01	0.00	0.00	0.00
0.02	0.00	0.00	0.00
0.03	0.01	0.01	0.00
0.04	0.01	0.01	0.00
0.05	0.02	0.02	0.00
0.06	0.03	0.03	0.00
0.07	0.04	0.04	0.00
0.08	0.06	0.07	0.00
0.09	0.10	0.10	0.01
0.1	0.14	0.15	0.01
0.11	0.21	0.22	0.02
0.12	0.29	0.31	0.03
0.13	0.41	0.43	0.04
0.14	0.55	0.59	0.07
0.15	0.73	0.79	0.10
0.16	0.95	1.02	0.15
0.17	1.20	1.31	0.22
0.18	1.47	1.62	0.30
0.19	1.77	1.97	0.42
0.2	2.06	2.34	0.55
0.21	2.34	2.70	0.72
0.22	2.59	3.04	0.90
0.23	2.78	3.33	1.10
0.24	2.91	3.55	1.28
0.25	2.95	3.66	1.41
0.26	2.92	3.63	1.43
0.27	2.80	3.38	1.16
0.28	2.61	2.61	0.00
0.29	2.37	1.78	-1.18
0.3	2.09	1.37	-1.45
0.31	1.80	1.08	-1.43
0.32	1.50	0.85	-1.30
0.33	1.22	0.67	-1.12
0.34	0.97	0.51	-0.92
0.35	0.75	0.39	-0.73
0.36	0.57	0.29	-0.57
0.37	0.42	0.21	-0.43
0.38	0.31	0.15	-0.31
0.39	0.22	0.10	-0.22
0.4	0.15	0.07	-0.16
0.41	0.10	0.05	-0.11
0.42	0.07	0.03	-0.07
0.43	0.04	0.02	-0.05
0.44	0.03	0.01	-0.03
0.45	0.02	0.01	-0.02
0.46	0.01	0.01	-0.01
0.47	0.01	0.00	-0.01
0.48	0.00	0.00	0.00
0.49	0.00	0.00	0.00
0.5	0.00	0.00	0.00

Shift:	0.280
Shifted Dist.	**Norm. Diff.**
-0.150	0.04
-0.140	0.07
-0.130	0.10
-0.120	0.15
-0.110	0.22
-0.100	0.30
-0.090	0.42
-0.080	0.55
-0.070	0.72
-0.060	0.90
-0.050	1.10
-0.040	1.28
-0.030	1.41
-0.020	1.43
-0.010	1.16
0.000	0.00
0.010	-1.18
0.020	-1.45
0.030	-1.43
0.040	-1.30
0.050	-1.12
0.060	-0.92
0.070	-0.73
0.080	-0.57
0.090	-0.43
0.100	-0.31
0.110	-0.22
0.120	-0.16
0.130	-0.11
0.140	-0.07

Shift	0.280
a1	0.603
a2	1.073
b1	0.235
b2	-0.251
w	19.530
c0	0.106
c1	-0.290
c2	-0.639
c3	-0.199
c4	-0.196

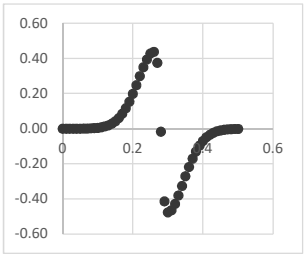


Crack: I26

Distance	Temperature		
	No Crack	Crack	Normalized Difference
0	0.00	0.00	0.00
0.01	0.00	0.00	0.00
0.02	0.00	0.00	0.00
0.03	0.01	0.01	0.00
0.04	0.01	0.01	0.00
0.05	0.02	0.02	0.00
0.06	0.03	0.03	0.00
0.07	0.04	0.04	0.00
0.08	0.06	0.07	0.00
0.09	0.10	0.10	0.00
0.1	0.14	0.15	0.00
0.11	0.21	0.21	0.01
0.12	0.29	0.30	0.01
0.13	0.41	0.42	0.02
0.14	0.55	0.57	0.03
0.15	0.73	0.76	0.04
0.16	0.95	0.98	0.06
0.17	1.20	1.24	0.09
0.18	1.47	1.53	0.12
0.19	1.77	1.84	0.15
0.2	2.06	2.16	0.20
0.21	2.34	2.47	0.25
0.22	2.59	2.74	0.30
0.23	2.78	2.96	0.35
0.24	2.91	3.10	0.39
0.25	2.95	3.17	0.43
0.26	2.92	3.13	0.44
0.27	2.80	2.99	0.37
0.28	2.61	2.60	-0.02
0.29	2.37	2.16	-0.41
0.3	2.09	1.85	-0.48
0.31	1.80	1.56	-0.46
0.32	1.50	1.29	-0.43
0.33	1.22	1.03	-0.38
0.34	0.97	0.81	-0.33
0.35	0.75	0.62	-0.27
0.36	0.57	0.46	-0.22
0.37	0.42	0.34	-0.17
0.38	0.31	0.24	-0.13
0.39	0.22	0.17	-0.10
0.4	0.15	0.11	-0.07
0.41	0.10	0.08	-0.05
0.42	0.07	0.05	-0.03
0.43	0.04	0.03	-0.02
0.44	0.03	0.02	-0.02
0.45	0.02	0.01	-0.01
0.46	0.01	0.01	-0.01
0.47	0.01	0.00	0.00
0.48	0.00	0.00	0.00
0.49	0.00	0.00	0.00
0.5	0.00	0.00	0.00

Shift:	0.280
Shifted Dist.	**Norm. Diff.**
-0.150	0.02
-0.140	0.03
-0.130	0.04
-0.120	0.06
-0.110	0.09
-0.100	0.12
-0.090	0.15
-0.080	0.20
-0.070	0.25
-0.060	0.30
-0.050	0.35
-0.040	0.39
-0.030	0.43
-0.020	0.44
-0.010	0.37
0.000	-0.02
0.010	-0.41
0.020	-0.48
0.030	-0.46
0.040	-0.43
0.050	-0.38
0.060	-0.33
0.070	-0.27
0.080	-0.22
0.090	-0.17
0.100	-0.13
0.110	-0.10
0.120	-0.07
0.130	-0.05
0.140	-0.03

Shift	0.280
a1	0.076
a2	0.498
b1	0.039
b2	0.053
w	19.494
c0	0.097
c1	-0.101
c2	-0.196
c3	-0.053
c4	-0.061

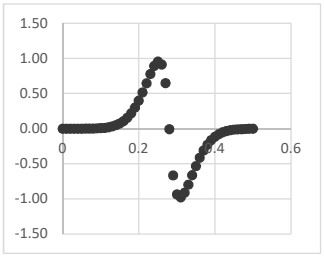


Crack: I27

Distance	Temperature		
	No Crack	Crack	Normalized Difference
0	0.00	0.00	0.00
0.01	0.00	0.00	0.00
0.02	0.00	0.00	0.00
0.03	0.01	0.01	0.00
0.04	0.01	0.01	0.00
0.05	0.02	0.02	0.00
0.06	0.03	0.03	0.00
0.07	0.04	0.04	0.00
0.08	0.06	0.07	0.00
0.09	0.10	0.10	0.00
0.1	0.14	0.15	0.01
0.11	0.21	0.21	0.01
0.12	0.29	0.31	0.02
0.13	0.41	0.42	0.03
0.14	0.55	0.58	0.05
0.15	0.73	0.77	0.07
0.16	0.95	1.00	0.11
0.17	1.20	1.28	0.16
0.18	1.47	1.58	0.22
0.19	1.77	1.92	0.30
0.2	2.06	2.26	0.40
0.21	2.34	2.60	0.52
0.22	2.59	2.91	0.65
0.23	2.78	3.17	0.78
0.24	2.91	3.35	0.89
0.25	2.95	3.43	0.96
0.26	2.92	3.37	0.91
0.27	2.80	3.12	0.65
0.28	2.61	2.61	-0.01
0.29	2.37	2.04	-0.67
0.3	2.09	1.62	-0.93
0.31	1.80	1.31	-0.98
0.32	1.50	1.05	-0.91
0.33	1.22	0.83	-0.80
0.34	0.97	0.64	-0.66
0.35	0.75	0.49	-0.53
0.36	0.57	0.36	-0.41
0.37	0.42	0.27	-0.31
0.38	0.31	0.19	-0.23
0.39	0.22	0.13	-0.16
0.4	0.15	0.09	-0.11
0.41	0.10	0.06	-0.08
0.42	0.07	0.04	-0.05
0.43	0.04	0.03	-0.03
0.44	0.03	0.02	-0.02
0.45	0.02	0.01	-0.01
0.46	0.01	0.01	-0.01
0.47	0.01	0.00	-0.01
0.48	0.00	0.00	0.00
0.49	0.00	0.00	0.00
0.5	0.00	0.00	0.00

Shift:	0.280
Shifted Dist.	**Norm. Diff.**
-0.150	0.03
-0.140	0.05
-0.130	0.07
-0.120	0.11
-0.110	0.16
-0.100	0.22
-0.090	0.30
-0.080	0.40
-0.070	0.52
-0.060	0.65
-0.050	0.78
-0.040	0.89
-0.030	0.96
-0.020	0.91
-0.010	0.65
0.000	-0.01
0.010	-0.67
0.020	-0.93
0.030	-0.98
0.040	-0.91
0.050	-0.80
0.060	-0.66
0.070	-0.53
0.080	-0.41
0.090	-0.31
0.100	-0.23
0.110	-0.16
0.120	-0.11
0.130	-0.08
0.140	-0.05

Shift	0.280
a1	0.408
a2	0.516
b1	0.220
b2	-0.096
w	19.500
c0	0.027
c1	-0.281
c2	-0.426
c3	-0.129
c4	-0.108

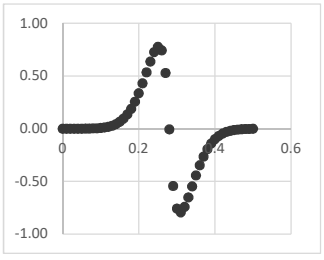


Crack: I28

Distance	Temperature		
	No Crack	Crack	Normalized Difference
0	0.00	0.00	0.00
0.01	0.00	0.00	0.00
0.02	0.00	0.00	0.00
0.03	0.01	0.01	0.00
0.04	0.01	0.01	0.00
0.05	0.02	0.02	0.00
0.06	0.03	0.03	0.00
0.07	0.04	0.04	0.00
0.08	0.06	0.07	0.00
0.09	0.10	0.10	0.00
0.1	0.14	0.15	0.01
0.11	0.21	0.21	0.01
0.12	0.29	0.30	0.02
0.13	0.41	0.42	0.03
0.14	0.55	0.58	0.04
0.15	0.73	0.77	0.07
0.16	0.95	1.00	0.09
0.17	1.20	1.27	0.14
0.18	1.47	1.57	0.19
0.19	1.77	1.89	0.26
0.2	2.06	2.23	0.34
0.21	2.34	2.56	0.43
0.22	2.59	2.86	0.53
0.23	2.78	3.10	0.64
0.24	2.91	3.27	0.73
0.25	2.95	3.34	0.78
0.26	2.92	3.29	0.74
0.27	2.80	3.06	0.53
0.28	2.61	2.61	-0.01
0.29	2.37	2.10	-0.54
0.3	2.09	1.71	-0.76
0.31	1.80	1.40	-0.79
0.32	1.50	1.13	-0.74
0.33	1.22	0.90	-0.65
0.34	0.97	0.70	-0.55
0.35	0.75	0.53	-0.44
0.36	0.57	0.40	-0.35
0.37	0.42	0.29	-0.26
0.38	0.31	0.21	-0.20
0.39	0.22	0.15	-0.14
0.4	0.15	0.10	-0.10
0.41	0.10	0.07	-0.07
0.42	0.07	0.04	-0.05
0.43	0.04	0.03	-0.03
0.44	0.03	0.02	-0.02
0.45	0.02	0.01	-0.01
0.46	0.01	0.01	-0.01
0.47	0.01	0.00	0.00
0.48	0.00	0.00	0.00
0.49	0.00	0.00	0.00
0.5	0.00	0.00	0.00

Shift:	0.280
Shifted Dist.	**Norm. Diff.**
-0.150	0.03
-0.140	0.04
-0.130	0.07
-0.120	0.09
-0.110	0.14
-0.100	0.19
-0.090	0.26
-0.080	0.34
-0.070	0.43
-0.060	0.53
-0.050	0.64
-0.040	0.73
-0.030	0.78
-0.020	0.74
-0.010	0.53
0.000	-0.01
0.010	-0.54
0.020	-0.76
0.030	-0.79
0.040	-0.74
0.050	-0.65
0.060	-0.55
0.070	-0.44
0.080	-0.35
0.090	-0.26
0.100	-0.20
0.110	-0.14
0.120	-0.10
0.130	-0.07
0.140	-0.05

Shift	0.280
a1	0.104
a2	0.287
b1	0.203
b2	-0.661
w	20.482
c0	0.044
c1	-0.375
c2	-0.343
c3	-0.136
c4	-0.089

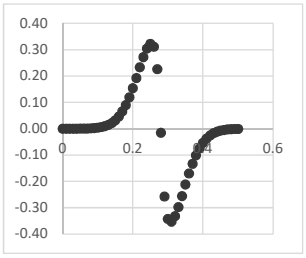


Crack: I29

Distance	Temperature		
	No Crack	Crack	Normalized Difference
0	0.00	0.00	0.00
0.01	0.00	0.00	0.00
0.02	0.00	0.00	0.00
0.03	0.01	0.01	0.00
0.04	0.01	0.01	0.00
0.05	0.02	0.02	0.00
0.06	0.03	0.03	0.00
0.07	0.04	0.04	0.00
0.08	0.06	0.07	0.00
0.09	0.10	0.10	0.00
0.1	0.14	0.15	0.00
0.11	0.21	0.21	0.01
0.12	0.29	0.30	0.01
0.13	0.41	0.42	0.01
0.14	0.55	0.57	0.02
0.15	0.73	0.75	0.03
0.16	0.95	0.97	0.05
0.17	1.20	1.23	0.07
0.18	1.47	1.52	0.09
0.19	1.77	1.83	0.12
0.2	2.06	2.14	0.15
0.21	2.34	2.44	0.19
0.22	2.59	2.70	0.23
0.23	2.78	2.92	0.27
0.24	2.91	3.06	0.30
0.25	2.95	3.11	0.32
0.26	2.92	3.07	0.31
0.27	2.80	2.91	0.23
0.28	2.61	2.60	-0.02
0.29	2.37	2.24	-0.26
0.3	2.09	1.92	-0.34
0.31	1.80	1.62	-0.35
0.32	1.50	1.34	-0.33
0.33	1.22	1.08	-0.30
0.34	0.97	0.84	-0.26
0.35	0.75	0.65	-0.21
0.36	0.57	0.49	-0.17
0.37	0.42	0.36	-0.13
0.38	0.31	0.25	-0.10
0.39	0.22	0.18	-0.07
0.4	0.15	0.12	-0.05
0.41	0.10	0.08	-0.04
0.42	0.07	0.05	-0.03
0.43	0.04	0.04	-0.02
0.44	0.03	0.02	-0.01
0.45	0.02	0.01	-0.01
0.46	0.01	0.01	0.00
0.47	0.01	0.01	0.00
0.48	0.00	0.00	0.00
0.49	0.00	0.00	0.00
0.5	0.00	0.00	0.00

Shift:	0.279
Shifted Dist.	**Norm. Diff.**
-0.149	0.01
-0.139	0.02
-0.129	0.03
-0.119	0.05
-0.109	0.07
-0.099	0.09
-0.089	0.12
-0.079	0.15
-0.069	0.19
-0.059	0.23
-0.049	0.27
-0.039	0.30
-0.029	0.32
-0.019	0.31
-0.009	0.23
0.001	-0.02
0.011	-0.26
0.021	-0.34
0.031	-0.35
0.041	-0.33
0.051	-0.30
0.061	-0.26
0.071	-0.21
0.081	-0.17
0.091	-0.13
0.101	-0.10
0.111	-0.07
0.121	-0.05
0.131	-0.04
0.141	-0.03

Shift	0.279
a1	0.252
a2	-0.122
b1	0.141
b2	0.105
w	22.856
c0	-0.104
c1	-0.215
c2	-0.131
c3	-0.059
c4	-0.026

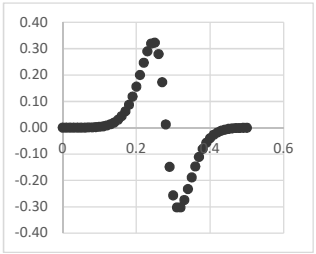


Crack: I30

Distance	Temperature		
	No Crack	Crack	Normalized Difference
0	0.00	0.00	0.00
0.01	0.00	0.00	0.00
0.02	0.00	0.00	0.00
0.03	0.01	0.01	0.00
0.04	0.01	0.01	0.00
0.05	0.02	0.02	0.00
0.06	0.03	0.03	0.00
0.07	0.04	0.04	0.00
0.08	0.06	0.07	0.00
0.09	0.10	0.10	0.00
0.1	0.14	0.15	0.00
0.11	0.21	0.21	0.01
0.12	0.29	0.30	0.01
0.13	0.41	0.42	0.01
0.14	0.55	0.56	0.02
0.15	0.73	0.75	0.03
0.16	0.95	0.97	0.04
0.17	1.20	1.23	0.06
0.18	1.47	1.52	0.09
0.19	1.77	1.82	0.12
0.2	2.06	2.14	0.16
0.21	2.34	2.44	0.20
0.22	2.59	2.71	0.25
0.23	2.78	2.93	0.29
0.24	2.91	3.07	0.32
0.25	2.95	3.11	0.32
0.26	2.92	3.05	0.28
0.27	2.80	2.88	0.17
0.28	2.61	2.62	0.01
0.29	2.37	2.29	-0.15
0.3	2.09	1.96	-0.26
0.31	1.80	1.64	-0.30
0.32	1.50	1.35	-0.30
0.33	1.22	1.09	-0.27
0.34	0.97	0.86	-0.23
0.35	0.75	0.66	-0.19
0.36	0.57	0.50	-0.15
0.37	0.42	0.37	-0.11
0.38	0.31	0.26	-0.08
0.39	0.22	0.19	-0.06
0.4	0.15	0.13	-0.04
0.41	0.10	0.09	-0.03
0.42	0.07	0.06	-0.02
0.43	0.04	0.04	-0.01
0.44	0.03	0.02	-0.01
0.45	0.02	0.02	0.00
0.46	0.01	0.01	0.00
0.47	0.01	0.01	0.00
0.48	0.00	0.00	0.00
0.49	0.00	0.00	0.00
0.5	0.00	0.00	0.00

Shift:	0.281
Shifted Dist.	Norm. Diff.
-0.141	0.02
-0.131	0.03
-0.121	0.04
-0.111	0.06
-0.101	0.09
-0.091	0.12
-0.081	0.16
-0.071	0.20
-0.061	0.25
-0.051	0.29
-0.041	0.32
-0.031	0.32
-0.021	0.28
-0.011	0.17
-0.001	0.01
0.009	-0.15
0.019	-0.26
0.029	-0.30
0.039	-0.30
0.049	-0.27
0.059	-0.23
0.069	-0.19
0.079	-0.15
0.089	-0.11
0.099	-0.08
0.109	-0.06
0.119	-0.04
0.129	-0.03
0.139	-0.02
0.149	-0.01

Shift	0.281
a1	-0.037
a2	0.100
b1	0.360
b2	0.143
w	22.160
c0	0.039
c1	-0.212
c2	-0.126
c3	-0.042
c4	-0.017

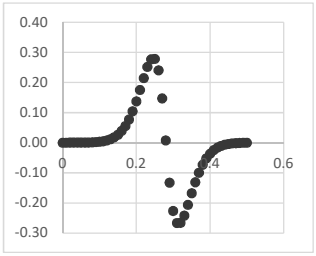


Crack: I31

Distance	Temperature		
	No Crack	Crack	Normalized Difference
0	0.00	0.00	0.00
0.01	0.00	0.00	0.00
0.02	0.00	0.00	0.00
0.03	0.01	0.01	0.00
0.04	0.01	0.01	0.00
0.05	0.02	0.02	0.00
0.06	0.03	0.03	0.00
0.07	0.04	0.04	0.00
0.08	0.06	0.07	0.00
0.09	0.10	0.10	0.00
0.1	0.14	0.15	0.00
0.11	0.21	0.21	0.00
0.12	0.29	0.30	0.01
0.13	0.41	0.41	0.01
0.14	0.55	0.56	0.02
0.15	0.73	0.75	0.03
0.16	0.95	0.97	0.04
0.17	1.20	1.23	0.06
0.18	1.47	1.51	0.08
0.19	1.77	1.82	0.10
0.2	2.06	2.13	0.14
0.21	2.34	2.43	0.17
0.22	2.59	2.70	0.21
0.23	2.78	2.91	0.25
0.24	2.91	3.05	0.28
0.25	2.95	3.09	0.28
0.26	2.92	3.04	0.24
0.27	2.80	2.87	0.15
0.28	2.61	2.61	0.01
0.29	2.37	2.30	-0.13
0.3	2.09	1.98	-0.23
0.31	1.80	1.66	-0.27
0.32	1.50	1.37	-0.27
0.33	1.22	1.10	-0.24
0.34	0.97	0.87	-0.21
0.35	0.75	0.67	-0.17
0.36	0.57	0.50	-0.13
0.37	0.42	0.37	-0.10
0.38	0.31	0.27	-0.07
0.39	0.22	0.19	-0.05
0.4	0.15	0.13	-0.04
0.41	0.10	0.09	-0.02
0.42	0.07	0.06	-0.02
0.43	0.04	0.04	-0.01
0.44	0.03	0.02	-0.01
0.45	0.02	0.02	0.00
0.46	0.01	0.01	0.00
0.47	0.01	0.01	0.00
0.48	0.00	0.00	0.00
0.49	0.00	0.00	0.00
0.5	0.00	0.00	0.00

Shift:	0.281
Shifted Dist.	Norm. Diff.
-0.141	0.02
-0.131	0.03
-0.121	0.04
-0.111	0.06
-0.101	0.08
-0.091	0.10
-0.081	0.14
-0.071	0.17
-0.061	0.21
-0.051	0.25
-0.041	0.28
-0.031	0.28
-0.021	0.24
-0.011	0.15
-0.001	0.01
0.009	-0.13
0.019	-0.23
0.029	-0.27
0.039	-0.27
0.049	-0.24
0.059	-0.21
0.069	-0.17
0.079	-0.13
0.089	-0.10
0.099	-0.07
0.109	-0.05
0.119	-0.04
0.129	-0.02
0.139	-0.02
0.149	-0.01

Shift	0.281
a1	0.061
a2	0.016
b1	0.116
b2	0.105
w	22.947
c0	-0.008
c1	-0.187
c2	-0.105
c3	-0.033
c4	-0.012

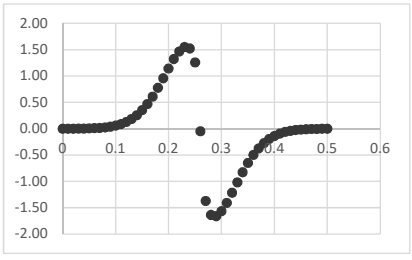


Crack: I32

Distance	Temperature		
	No Crack	Crack	Normalized Difference
0	0.00	0.00	0.00
0.01	0.00	0.00	0.00
0.02	0.00	0.00	0.00
0.03	0.01	0.01	0.00
0.04	0.01	0.01	0.00
0.05	0.02	0.02	0.01
0.06	0.03	0.03	0.01
0.07	0.04	0.05	0.02
0.08	0.06	0.08	0.02
0.09	0.10	0.12	0.04
0.1	0.14	0.17	0.06
0.11	0.21	0.25	0.09
0.12	0.29	0.36	0.13
0.13	0.41	0.50	0.18
0.14	0.55	0.68	0.26
0.15	0.73	0.91	0.35
0.16	0.95	1.18	0.47
0.17	1.20	1.50	0.61
0.18	1.47	1.86	0.78
0.19	1.77	2.24	0.96
0.2	2.06	2.63	1.14
0.21	2.34	3.00	1.32
0.22	2.59	3.32	1.47
0.23	2.78	3.56	1.55
0.24	2.91	3.67	1.52
0.25	2.95	3.58	1.26
0.26	2.92	2.89	-0.05
0.27	2.80	2.11	-1.37
0.28	2.61	1.79	-1.64
0.29	2.37	1.54	-1.66
0.3	2.09	1.31	-1.56
0.31	1.80	1.09	-1.41
0.32	1.50	0.89	-1.22
0.33	1.22	0.72	-1.02
0.34	0.97	0.56	-0.83
0.35	0.75	0.43	-0.65
0.36	0.57	0.32	-0.50
0.37	0.42	0.23	-0.37
0.38	0.31	0.17	-0.27
0.39	0.22	0.12	-0.19
0.4	0.15	0.08	-0.14
0.41	0.10	0.06	-0.09
0.42	0.07	0.04	-0.06
0.43	0.04	0.02	-0.04
0.44	0.03	0.02	-0.03
0.45	0.02	0.01	-0.02
0.46	0.01	0.01	-0.01
0.47	0.01	0.00	-0.01
0.48	0.00	0.00	0.00
0.49	0.00	0.00	0.00
0.5	0.00	0.00	0.00

Shift:	0.260
Shifted Dist.	**Norm. Diff.**
-0.150	0.09
-0.140	0.13
-0.130	0.18
-0.120	0.26
-0.110	0.35
-0.100	0.47
-0.090	0.61
-0.080	0.78
-0.070	0.96
-0.060	1.14
-0.050	1.32
-0.040	1.47
-0.030	1.55
-0.020	1.52
-0.010	1.26
0.000	-0.05
0.010	-1.37
0.020	-1.64
0.030	-1.66
0.040	-1.56
0.050	-1.41
0.060	-1.22
0.070	-1.02
0.080	-0.83
0.090	-0.65
0.100	-0.50
0.110	-0.37
0.120	-0.27
0.130	-0.19
0.140	-0.14

Shift	0.260
a1	0.943
a2	1.029
b1	0.185
b2	-0.521
w	19.302
c0	0.011
c1	-0.417
c2	-0.699
c3	-0.177
c4	-0.197

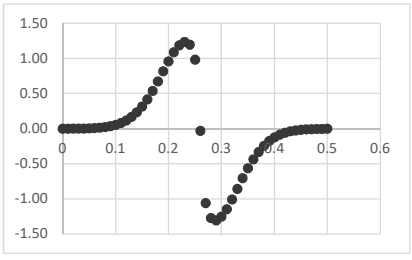


Crack: I33

Distance	Temperature		
	No Crack	Crack	Normalized Difference
0	0.00	0.00	0.00
0.01	0.00	0.00	0.00
0.02	0.00	0.00	0.00
0.03	0.01	0.01	0.00
0.04	0.01	0.01	0.00
0.05	0.02	0.02	0.01
0.06	0.03	0.03	0.01
0.07	0.04	0.05	0.01
0.08	0.06	0.08	0.02
0.09	0.10	0.12	0.04
0.1	0.14	0.17	0.05
0.11	0.21	0.25	0.08
0.12	0.29	0.35	0.12
0.13	0.41	0.49	0.17
0.14	0.55	0.67	0.23
0.15	0.73	0.89	0.32
0.16	0.95	1.16	0.42
0.17	1.20	1.47	0.54
0.18	1.47	1.81	0.67
0.19	1.77	2.17	0.82
0.2	2.06	2.54	0.96
0.21	2.34	2.89	1.09
0.22	2.59	3.18	1.19
0.23	2.78	3.40	1.24
0.24	2.91	3.51	1.20
0.25	2.95	3.44	0.98
0.26	2.92	2.90	-0.03
0.27	2.80	2.27	-1.06
0.28	2.61	1.97	-1.27
0.29	2.37	1.72	-1.31
0.3	2.09	1.46	-1.25
0.31	1.80	1.22	-1.15
0.32	1.50	1.00	-1.01
0.33	1.22	0.80	-0.86
0.34	0.97	0.62	-0.71
0.35	0.75	0.47	-0.56
0.36	0.57	0.35	-0.44
0.37	0.42	0.26	-0.33
0.38	0.31	0.18	-0.24
0.39	0.22	0.13	-0.18
0.4	0.15	0.09	-0.12
0.41	0.10	0.06	-0.09
0.42	0.07	0.04	-0.06
0.43	0.04	0.03	-0.04
0.44	0.03	0.02	-0.02
0.45	0.02	0.01	-0.02
0.46	0.01	0.01	-0.01
0.47	0.01	0.00	-0.01
0.48	0.00	0.00	0.00
0.49	0.00	0.00	0.00
0.5	0.00	0.00	0.00

Shift:	0.260
Shifted Dist.	**Norm. Diff.**
-0.150	0.08
-0.140	0.12
-0.130	0.17
-0.120	0.23
-0.110	0.32
-0.100	0.42
-0.090	0.54
-0.080	0.67
-0.070	0.82
-0.060	0.96
-0.050	1.09
-0.040	1.19
-0.030	1.24
-0.020	1.20
-0.010	0.98
0.000	-0.03
0.010	-1.06
0.020	-1.27
0.030	-1.31
0.040	-1.25
0.050	-1.15
0.060	-1.01
0.070	-0.86
0.080	-0.71
0.090	-0.56
0.100	-0.44
0.110	-0.33
0.120	-0.24
0.130	-0.18
0.140	-0.12

Shift	0.260
a1	0.363
a2	0.458
b1	0.699
b2	-0.117
w	22.006
c0	0.013
c1	-0.742
c2	-0.496
c3	-0.184
c4	-0.137

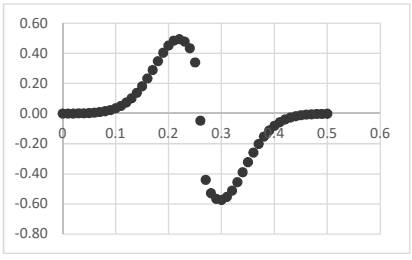


Crack: I34

Distance	Temperature		
	No Crack	Crack	Normalized Difference
0	0.00	0.00	0.00
0.01	0.00	0.00	0.00
0.02	0.00	0.00	0.00
0.03	0.01	0.01	0.00
0.04	0.01	0.01	0.00
0.05	0.02	0.02	0.00
0.06	0.03	0.03	0.01
0.07	0.04	0.05	0.01
0.08	0.06	0.07	0.02
0.09	0.10	0.11	0.02
0.1	0.14	0.16	0.04
0.11	0.21	0.23	0.05
0.12	0.29	0.33	0.07
0.13	0.41	0.46	0.10
0.14	0.55	0.62	0.14
0.15	0.73	0.82	0.18
0.16	0.95	1.07	0.23
0.17	1.20	1.34	0.29
0.18	1.47	1.65	0.35
0.19	1.77	1.97	0.41
0.2	2.06	2.29	0.45
0.21	2.34	2.58	0.48
0.22	2.59	2.84	0.49
0.23	2.78	3.02	0.48
0.24	2.91	3.12	0.43
0.25	2.95	3.12	0.34
0.26	2.92	2.89	-0.05
0.27	2.80	2.58	-0.44
0.28	2.61	2.35	-0.53
0.29	2.37	2.09	-0.57
0.3	2.09	1.80	-0.57
0.31	1.80	1.52	-0.55
0.32	1.50	1.25	-0.51
0.33	1.22	1.00	-0.45
0.34	0.97	0.78	-0.39
0.35	0.75	0.59	-0.32
0.36	0.57	0.44	-0.26
0.37	0.42	0.32	-0.20
0.38	0.31	0.23	-0.15
0.39	0.22	0.16	-0.11
0.4	0.15	0.11	-0.08
0.41	0.10	0.07	-0.06
0.42	0.07	0.05	-0.04
0.43	0.04	0.03	-0.03
0.44	0.03	0.02	-0.02
0.45	0.02	0.01	-0.01
0.46	0.01	0.01	-0.01
0.47	0.01	0.00	0.00
0.48	0.00	0.00	0.00
0.49	0.00	0.00	0.00
0.5	0.00	0.00	0.00

Shift:	0.259
Shifted Dist.	**Norm. Diff.**
-0.149	0.05
-0.139	0.07
-0.129	0.10
-0.119	0.14
-0.109	0.18
-0.099	0.23
-0.089	0.29
-0.079	0.35
-0.069	0.41
-0.059	0.45
-0.049	0.48
-0.039	0.49
-0.029	0.48
-0.019	0.43
-0.009	0.34
0.001	-0.05
0.011	-0.44
0.021	-0.53
0.031	-0.57
0.041	-0.57
0.051	-0.55
0.061	-0.51
0.071	-0.45
0.081	-0.39
0.091	-0.32
0.101	-0.26
0.111	-0.20
0.121	-0.15
0.131	-0.11
0.141	-0.08

Shift	0.259
a1	-0.224
a2	0.553
b1	-0.534
b2	0.285
w	23.320
c0	0.168
c1	-0.408
c2	-0.153
c3	-0.047
c4	-0.045

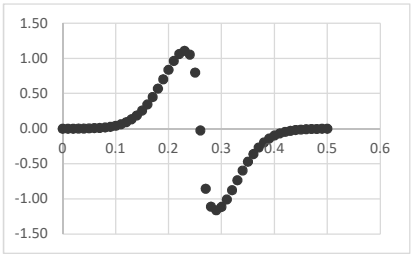


Crack: I35

Distance	Temperature		
	No Crack	Crack	Normalized Difference
0	0.00	0.00	0.00
0.01	0.00	0.00	0.00
0.02	0.00	0.00	0.00
0.03	0.01	0.01	0.00
0.04	0.01	0.01	0.00
0.05	0.02	0.02	0.00
0.06	0.03	0.03	0.01
0.07	0.04	0.05	0.01
0.08	0.06	0.07	0.02
0.09	0.10	0.11	0.03
0.1	0.14	0.17	0.04
0.11	0.21	0.24	0.06
0.12	0.29	0.34	0.09
0.13	0.41	0.48	0.13
0.14	0.55	0.65	0.19
0.15	0.73	0.86	0.26
0.16	0.95	1.12	0.34
0.17	1.20	1.42	0.45
0.18	1.47	1.76	0.57
0.19	1.77	2.12	0.70
0.2	2.06	2.48	0.84
0.21	2.34	2.82	0.97
0.22	2.59	3.12	1.06
0.23	2.78	3.34	1.11
0.24	2.91	3.43	1.06
0.25	2.95	3.35	0.80
0.26	2.92	2.90	-0.02
0.27	2.80	2.37	-0.86
0.28	2.61	2.06	-1.11
0.29	2.37	1.79	-1.16
0.3	2.09	1.53	-1.11
0.31	1.80	1.29	-1.01
0.32	1.50	1.06	-0.88
0.33	1.22	0.86	-0.73
0.34	0.97	0.67	-0.60
0.35	0.75	0.52	-0.47
0.36	0.57	0.39	-0.36
0.37	0.42	0.29	-0.27
0.38	0.31	0.21	-0.20
0.39	0.22	0.15	-0.14
0.4	0.15	0.10	-0.10
0.41	0.10	0.07	-0.07
0.42	0.07	0.05	-0.04
0.43	0.04	0.03	-0.03
0.44	0.03	0.02	-0.02
0.45	0.02	0.01	-0.01
0.46	0.01	0.01	-0.01
0.47	0.01	0.00	0.00
0.48	0.00	0.00	0.00
0.49	0.00	0.00	0.00
0.5	0.00	0.00	0.00

Shift:	0.260
Shifted Dist.	**Norm. Diff.**
-0.150	0.06
-0.140	0.09
-0.130	0.13
-0.120	0.19
-0.110	0.26
-0.100	0.34
-0.090	0.45
-0.080	0.57
-0.070	0.70
-0.060	0.84
-0.050	0.97
-0.040	1.06
-0.030	1.11
-0.020	1.06
-0.010	0.80
0.000	-0.02
0.010	-0.86
0.020	-1.11
0.030	-1.16
0.040	-1.11
0.050	-1.01
0.060	-0.88
0.070	-0.73
0.080	-0.60
0.090	-0.47
0.100	-0.36
0.110	-0.27
0.120	-0.20
0.130	-0.14
0.140	-0.10

Shift	0.260
a1	0.497
a2	0.567
b1	0.110
b2	-0.125
w	27.123
c0	0.016
c1	-0.697
c2	-0.337
c3	-0.109
c4	-0.049

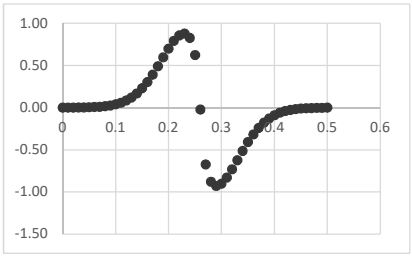


Crack: I36

Distance	Temperature		
	No Crack	Crack	Normalized Difference
0	0.00	0.00	0.00
0.01	0.00	0.00	0.00
0.02	0.00	0.00	0.00
0.03	0.01	0.01	0.00
0.04	0.01	0.01	0.00
0.05	0.02	0.02	0.00
0.06	0.03	0.03	0.01
0.07	0.04	0.05	0.01
0.08	0.06	0.07	0.02
0.09	0.10	0.11	0.03
0.1	0.14	0.16	0.04
0.11	0.21	0.24	0.06
0.12	0.29	0.34	0.09
0.13	0.41	0.47	0.12
0.14	0.55	0.64	0.17
0.15	0.73	0.85	0.23
0.16	0.95	1.10	0.30
0.17	1.20	1.39	0.39
0.18	1.47	1.72	0.49
0.19	1.77	2.06	0.60
0.2	2.06	2.41	0.70
0.21	2.34	2.74	0.79
0.22	2.59	3.02	0.86
0.23	2.78	3.22	0.88
0.24	2.91	3.32	0.83
0.25	2.95	3.26	0.62
0.26	2.92	2.90	-0.02
0.27	2.80	2.46	-0.67
0.28	2.61	2.17	-0.88
0.29	2.37	1.90	-0.93
0.3	2.09	1.64	-0.90
0.31	1.80	1.38	-0.83
0.32	1.50	1.14	-0.73
0.33	1.22	0.91	-0.62
0.34	0.97	0.72	-0.51
0.35	0.75	0.55	-0.41
0.36	0.57	0.41	-0.32
0.37	0.42	0.30	-0.24
0.38	0.31	0.22	-0.18
0.39	0.22	0.15	-0.13
0.4	0.15	0.10	-0.09
0.41	0.10	0.07	-0.06
0.42	0.07	0.05	-0.04
0.43	0.04	0.03	-0.03
0.44	0.03	0.02	-0.02
0.45	0.02	0.01	-0.01
0.46	0.01	0.01	-0.01
0.47	0.01	0.00	0.00
0.48	0.00	0.00	0.00
0.49	0.00	0.00	0.00
0.5	0.00	0.00	0.00

Shift:	0.260
Shifted Dist.	**Norm. Diff.**
-0.150	0.06
-0.140	0.09
-0.130	0.12
-0.120	0.17
-0.110	0.23
-0.100	0.30
-0.090	0.39
-0.080	0.49
-0.070	0.60
-0.060	0.70
-0.050	0.79
-0.040	0.86
-0.030	0.88
-0.020	0.83
-0.010	0.62
0.000	-0.02
0.010	-0.67
0.020	-0.88
0.030	-0.93
0.040	-0.90
0.050	-0.83
0.060	-0.73
0.070	-0.62
0.080	-0.51
0.090	-0.41
0.100	-0.32
0.110	-0.24
0.120	-0.18
0.130	-0.13
0.140	-0.09

Shift	0.260
a1	0.161
a2	0.916
b1	-0.022
b2	-0.208
w	28.321
c0	0.190
c1	-0.528
c2	-0.225
c3	-0.063
c4	-0.014

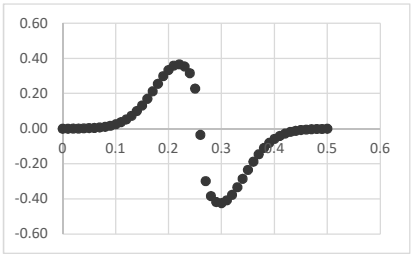


Crack: I37

Distance	Temperature		
	No Crack	Crack	Normalized Difference
0	0.00	0.00	0.00
0.01	0.00	0.00	0.00
0.02	0.00	0.00	0.00
0.03	0.01	0.01	0.00
0.04	0.01	0.01	0.00
0.05	0.02	0.02	0.00
0.06	0.03	0.03	0.00
0.07	0.04	0.05	0.01
0.08	0.06	0.07	0.01
0.09	0.10	0.11	0.02
0.1	0.14	0.16	0.03
0.11	0.21	0.23	0.04
0.12	0.29	0.32	0.05
0.13	0.41	0.45	0.07
0.14	0.55	0.60	0.10
0.15	0.73	0.80	0.13
0.16	0.95	1.03	0.17
0.17	1.20	1.30	0.21
0.18	1.47	1.60	0.26
0.19	1.77	1.92	0.30
0.2	2.06	2.23	0.33
0.21	2.34	2.52	0.36
0.22	2.59	2.77	0.37
0.23	2.78	2.96	0.35
0.24	2.91	3.06	0.32
0.25	2.95	3.07	0.23
0.26	2.92	2.90	-0.03
0.27	2.80	2.65	-0.30
0.28	2.61	2.42	-0.38
0.29	2.37	2.16	-0.42
0.3	2.09	1.88	-0.42
0.31	1.80	1.59	-0.41
0.32	1.50	1.31	-0.38
0.33	1.22	1.06	-0.33
0.34	0.97	0.83	-0.28
0.35	0.75	0.64	-0.24
0.36	0.57	0.48	-0.19
0.37	0.42	0.35	-0.15
0.38	0.31	0.25	-0.11
0.39	0.22	0.18	-0.08
0.4	0.15	0.12	-0.06
0.41	0.10	0.08	-0.04
0.42	0.07	0.05	-0.03
0.43	0.04	0.03	-0.02
0.44	0.03	0.02	-0.01
0.45	0.02	0.01	-0.01
0.46	0.01	0.01	0.00
0.47	0.01	0.01	0.00
0.48	0.00	0.00	0.00
0.49	0.00	0.00	0.00
0.5	0.00	0.00	0.00

Shift:	0.259
Shifted Dist.	**Norm. Diff.**
-0.149	0.04
-0.139	0.05
-0.129	0.07
-0.119	0.10
-0.109	0.13
-0.099	0.17
-0.089	0.21
-0.079	0.26
-0.069	0.30
-0.059	0.33
-0.049	0.36
-0.039	0.37
-0.029	0.35
-0.019	0.32
-0.009	0.23
0.001	-0.03
0.011	-0.30
0.021	-0.38
0.031	-0.42
0.041	-0.42
0.051	-0.41
0.061	-0.38
0.071	-0.33
0.081	-0.28
0.091	-0.24
0.101	-0.19
0.111	-0.15
0.121	-0.11
0.131	-0.08
0.141	-0.06

Shift	0.259
a1	0.181
a2	0.058
b1	0.042
b2	0.123
w	22.842
c0	-0.047
c1	-0.290
c2	-0.122
c3	-0.037
c4	-0.024

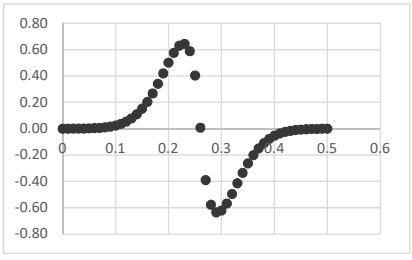


Crack: I38

Distance	Temperature		
	No Crack	Crack	Normalized Difference
0	0.00	0.00	0.00
0.01	0.00	0.00	0.00
0.02	0.00	0.00	0.00
0.03	0.01	0.01	0.00
0.04	0.01	0.01	0.00
0.05	0.02	0.02	0.00
0.06	0.03	0.03	0.00
0.07	0.04	0.05	0.01
0.08	0.06	0.07	0.01
0.09	0.10	0.11	0.02
0.1	0.14	0.16	0.02
0.11	0.21	0.23	0.04
0.12	0.29	0.32	0.05
0.13	0.41	0.45	0.08
0.14	0.55	0.61	0.11
0.15	0.73	0.81	0.15
0.16	0.95	1.05	0.20
0.17	1.20	1.33	0.27
0.18	1.47	1.64	0.34
0.19	1.77	1.98	0.42
0.2	2.06	2.31	0.50
0.21	2.34	2.63	0.58
0.22	2.59	2.90	0.63
0.23	2.78	3.10	0.64
0.24	2.91	3.20	0.59
0.25	2.95	3.15	0.40
0.26	2.92	2.92	0.01
0.27	2.80	2.60	-0.39
0.28	2.61	2.32	-0.58
0.29	2.37	2.05	-0.63
0.3	2.09	1.78	-0.62
0.31	1.80	1.51	-0.57
0.32	1.50	1.25	-0.50
0.33	1.22	1.02	-0.41
0.34	0.97	0.80	-0.34
0.35	0.75	0.62	-0.26
0.36	0.57	0.47	-0.20
0.37	0.42	0.35	-0.15
0.38	0.31	0.25	-0.11
0.39	0.22	0.18	-0.08
0.4	0.15	0.12	-0.05
0.41	0.10	0.08	-0.04
0.42	0.07	0.06	-0.02
0.43	0.04	0.04	-0.02
0.44	0.03	0.02	-0.01
0.45	0.02	0.01	-0.01
0.46	0.01	0.01	0.00
0.47	0.01	0.01	0.00
0.48	0.00	0.00	0.00
0.49	0.00	0.00	0.00
0.5	0.00	0.00	0.00

Shift:	0.260
Shifted Dist.	**Norm. Diff.**
-0.140	0.05
-0.130	0.08
-0.120	0.11
-0.110	0.15
-0.100	0.20
-0.090	0.27
-0.080	0.34
-0.070	0.42
-0.060	0.50
-0.050	0.58
-0.040	0.63
-0.030	0.64
-0.020	0.59
-0.010	0.40
0.000	0.01
0.010	-0.39
0.020	-0.58
0.030	-0.63
0.040	-0.62
0.050	-0.57
0.060	-0.50
0.070	-0.41
0.080	-0.34
0.090	-0.26
0.100	-0.20
0.110	-0.15
0.120	-0.11
0.130	-0.08
0.140	-0.05
0.150	-0.04

Shift	0.260
a1	0.324
a2	0.377
b1	0.046
b2	-0.183
w	18.813
c0	0.013
c1	-0.195
c2	-0.275
c3	-0.065
c4	-0.058

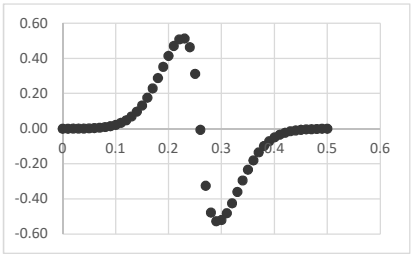


Crack: I39

Distance	Temperature		
	No Crack	Crack	Normalized Difference
0	0.00	0.00	0.00
0.01	0.00	0.00	0.00
0.02	0.00	0.00	0.00
0.03	0.01	0.01	0.00
0.04	0.01	0.01	0.00
0.05	0.02	0.02	0.00
0.06	0.03	0.03	0.00
0.07	0.04	0.05	0.01
0.08	0.06	0.07	0.01
0.09	0.10	0.10	0.01
0.1	0.14	0.16	0.02
0.11	0.21	0.22	0.03
0.12	0.29	0.32	0.05
0.13	0.41	0.44	0.07
0.14	0.55	0.60	0.10
0.15	0.73	0.80	0.13
0.16	0.95	1.04	0.18
0.17	1.20	1.31	0.23
0.18	1.47	1.62	0.29
0.19	1.77	1.94	0.35
0.2	2.06	2.27	0.42
0.21	2.34	2.58	0.47
0.22	2.59	2.84	0.51
0.23	2.78	3.04	0.51
0.24	2.91	3.14	0.46
0.25	2.95	3.11	0.31
0.26	2.92	2.91	-0.01
0.27	2.80	2.64	-0.33
0.28	2.61	2.37	-0.48
0.29	2.37	2.11	-0.53
0.3	2.09	1.83	-0.52
0.31	1.80	1.55	-0.48
0.32	1.50	1.29	-0.42
0.33	1.22	1.04	-0.36
0.34	0.97	0.83	-0.29
0.35	0.75	0.64	-0.23
0.36	0.57	0.48	-0.18
0.37	0.42	0.35	-0.14
0.38	0.31	0.26	-0.10
0.39	0.22	0.18	-0.07
0.4	0.15	0.12	-0.05
0.41	0.10	0.08	-0.03
0.42	0.07	0.06	-0.02
0.43	0.04	0.04	-0.01
0.44	0.03	0.02	-0.01
0.45	0.02	0.01	-0.01
0.46	0.01	0.01	0.00
0.47	0.01	0.01	0.00
0.48	0.00	0.00	0.00
0.49	0.00	0.00	0.00
0.5	0.00	0.00	0.00

Shift:	0.260
Shifted Dist.	**Norm. Diff.**
-0.150	0.03
-0.140	0.05
-0.130	0.07
-0.120	0.10
-0.110	0.13
-0.100	0.18
-0.090	0.23
-0.080	0.29
-0.070	0.35
-0.060	0.42
-0.050	0.47
-0.040	0.51
-0.030	0.51
-0.020	0.46
-0.010	0.31
0.000	-0.01
0.010	-0.33
0.020	-0.48
0.030	-0.53
0.040	-0.52
0.050	-0.48
0.060	-0.42
0.070	-0.36
0.080	-0.29
0.090	-0.23
0.100	-0.18
0.110	-0.14
0.120	-0.10
0.130	-0.07
0.140	-0.05

Shift	0.260
a1	0.182
a2	0.152
b1	0.141
b2	0.408
w	19.935
c0	-0.010
c1	-0.270
c2	-0.217
c3	-0.065
c4	-0.043

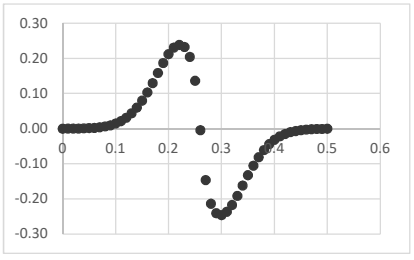


Crack: I40

Distance	Temperature		
	No Crack	Crack	Normalized Difference
0	0.00	0.00	0.00
0.01	0.00	0.00	0.00
0.02	0.00	0.00	0.00
0.03	0.01	0.01	0.00
0.04	0.01	0.01	0.00
0.05	0.02	0.02	0.00
0.06	0.03	0.03	0.00
0.07	0.04	0.04	0.00
0.08	0.06	0.07	0.01
0.09	0.10	0.10	0.01
0.1	0.14	0.15	0.01
0.11	0.21	0.22	0.02
0.12	0.29	0.31	0.03
0.13	0.41	0.43	0.04
0.14	0.55	0.58	0.06
0.15	0.73	0.77	0.08
0.16	0.95	1.00	0.10
0.17	1.20	1.26	0.13
0.18	1.47	1.55	0.16
0.19	1.77	1.86	0.19
0.2	2.06	2.17	0.21
0.21	2.34	2.46	0.23
0.22	2.59	2.71	0.24
0.23	2.78	2.90	0.23
0.24	2.91	3.01	0.20
0.25	2.95	3.02	0.14
0.26	2.92	2.91	0.00
0.27	2.80	2.72	-0.15
0.28	2.61	2.50	-0.21
0.29	2.37	2.25	-0.24
0.3	2.09	1.97	-0.25
0.31	1.80	1.68	-0.24
0.32	1.50	1.39	-0.22
0.33	1.22	1.13	-0.19
0.34	0.97	0.89	-0.16
0.35	0.75	0.69	-0.13
0.36	0.57	0.52	-0.11
0.37	0.42	0.38	-0.08
0.38	0.31	0.27	-0.06
0.39	0.22	0.19	-0.04
0.4	0.15	0.13	-0.03
0.41	0.10	0.09	-0.02
0.42	0.07	0.06	-0.01
0.43	0.04	0.04	-0.01
0.44	0.03	0.03	-0.01
0.45	0.02	0.02	0.00
0.46	0.01	0.01	0.00
0.47	0.01	0.01	0.00
0.48	0.00	0.00	0.00
0.49	0.00	0.00	0.00
0.5	0.00	0.00	0.00

Shift:	0.260
Shifted Dist.	**Norm. Diff.**
-0.150	0.02
-0.140	0.03
-0.130	0.04
-0.120	0.06
-0.110	0.08
-0.100	0.10
-0.090	0.13
-0.080	0.16
-0.070	0.19
-0.060	0.21
-0.050	0.23
-0.040	0.24
-0.030	0.23
-0.020	0.20
-0.010	0.14
0.000	0.00
0.010	-0.15
0.020	-0.21
0.030	-0.24
0.040	-0.25
0.050	-0.24
0.060	-0.22
0.070	-0.19
0.080	-0.16
0.090	-0.13
0.100	-0.11
0.110	-0.08
0.120	-0.06
0.130	-0.04
0.140	-0.03

Shift	0.260
a1	0.010
a2	0.096
b1	-0.064
b2	0.162
w	21.761
c0	0.020
c1	-0.176
c2	-0.083
c3	-0.026
c4	-0.013



Appendix B: MATLAB Codes

CODE 1 – Best Fit Using Full Equation (Crack I12)

```
clear;clc
clear;clc
x=[-0.1406,-0.1306,-0.1206,-0.1106,-0.1006,-
0.0906,-0.0806,-0.0706,-0.0606,-0.0506,-0.0406,-
0.0306,-0.0206,-0.0106,-
0.0006,0.0094,0.0194,0.0294,0.0394,0.0494,0.0594,
0.0694,0.0794,0.0894,0.0994,0.1094,0.1194,0.1294,
0.1394,0.1494];
y=[0.02,0.02,0.02,0.02,0.03,0.03,0.03,0.04,0.05,0
.07,0.09,0.11,0.13,0.12,0.01,-0.10,-0.12,-0.10,-
0.07,-0.05,-0.04,-0.03,-0.02,-0.01,-
0.01,0.00,0.00,0.00,0.00,0.00];
pts=max(size(x));
zin(1)=0;zin(2)=0;zin(3)=0;zin(4)=0;zin(5)=0;
zin(6)=0;zin(7)=0;zin(8)=0;zin(9)=0;zin(10)=0;
zout=fminsearch(@(z) sumoferrs(z,x,y), zin)
xplot=x(1):(x(end)-x(1))/(10*pts):x(end);
yplot=curve(xplot,zout);
plot(x,y,'+',xplot,yplot)
Z=transpose(zout)
function f=curve(x,z)
xo=0;
a1=z(1);a2=z(2);
b1=z(3);b2=z(4);
w=z(5);
c0=z(6);c1=z(7);c2=z(8);c3=z(9);c4=z(10);
f=a1./(1+exp(b1*abs(x))).*(x<xo)+ -
a2./(1+exp(b2*abs(x))).*(x>xo) + c0 +
c1*sin(w*x)+c2*sin(2*w*x)+c3*sin(3*w*x)+c4*sin(4*
w*x);
end
function f=sumoferrs(z, x, y)
f=sum((curve(x,z)-y).^2);
end
```

CODE 2 – Multivariable Linear Regression for Surface Cracks

```
close all; clear all; clc
F2=[0.10559362  3.4159  2.5 49.6889 45.427
0.105639364 3.1567  2.2444  53.1537 47.5009
0.105912759 2.235   1.3504  66.8774 54.1133
0.055367514 9.2439  7.8438  30.5001 32.9002
0.055324933 7.6471  6.5717  32.972  33.3874
0.055495901 3.8755  3.0645  40.3819 34.1504
0.035137775 11.2348 10.4927 26.1469 27.9341
0.035157302 9.2167  8.534   26.2622 27.4297
0.035238569 3.7009  3.4851  26.1683 25.2776
0.014877538 12.2713 12.7184 21.1141 23.1435
0.014830876 9.782   10.4019 20.2159 22.1602
0.014388201 3.2338  4.312   15.0644 17.7045];

A=[10   10
10  5
10  2.5
5   10
5   5
5   2.5
3   10
3   5
3   2.5
1   10
1   5
1   2.5];

beta2=mvregress(F2,A)

Check2=[F2(1,:)*beta2
    F2(2,:)*beta2
    F2(3,:)*beta2
    F2(4,:)*beta2
    F2(5,:)*beta2
    F2(6,:)*beta2
    F2(7,:)*beta2
    F2(8,:)*beta2
    F2(9,:)*beta2
    F2(10,:)*beta2
    F2(11,:)*beta2
    F2(12,:)*beta2]
```

CODE 3 – Multivariable Linear Regression for Internal Cracks

```
close all; clear all; clc
F2=[0.099974307 0.134   0.0714  0.0356  0.3116  32.2575 -0.0241 -0.2258 -0.193  -0.1267 -0.0465
0.100178835 0.0625  0.1378  0.1048  -0.0125 32.3526 0.0169  -0.1816 -0.1671 -0.1101 -0.0549
0.100195561 0.0694  0.0299  0.1365  0.0425  33.1037 -0.011  -0.0892 -0.0879 -0.0639 -0.0358
0.100188303 0.1525  0.0401  0.1654  0.1364  31.0187 -0.027  -0.1801 -0.1553 -0.0895 -0.0386
0.100139563 0.0961  0.0666  0.206   -0.0203 31.5537 -0.0082 -0.1506 -0.1334 -0.0805 -0.0353
0.100073498 0.0425  0.029   0.0399  0.1035  32.4888 -0.0067 -0.0755 -0.0715 -0.0485 -0.0244
0.100020865 0.074   0.0183  -0.0106 0.0174  29.3038 -0.0174 -0.1309 -0.1064 -0.0531 -0.0202
0.100080171 -0.101  0.1784  0.0851  -0.033  29.1978 0.0677  -0.1121 -0.0934 -0.0474 -0.0193
0.10057236  0.0545  0.0267  0.0304  0.0059  30.7046 0.0004  -0.055  -0.0471 -0.0271 -0.0103
0.099363673 0.0558  -0.066  0.0481  -0.0564 25.5667 -0.0367 -0.0515 -0.0381 -0.015  -0.0063
0.05113059  0.4391  1.0487  0.5683  -0.4263 20.8414 0.1683  -0.3233 -0.6259 -0.2545 -0.246
0.051184305 0.3711  0.6308  0.641   -0.4959 31.5229 0.0634  -0.6453 -0.4616 -0.2571 -0.1056
0.051305981 0.2279  0.1916  -0.0344 -0.0352 21.4217 -0.0049 -0.1498 -0.2321 -0.1108 -0.1055
0.051025597 0.4648  0.2371  0.8147  -0.2069 28.2731 -0.0499 -0.6914 -0.4839 -0.2251 -0.1037
0.050794647 0.4495  0.5879  0.2354  -0.385  20.0688 0.0289  -0.1531 -0.4295 -0.1624 -0.1674
0.050983402 0.2074  0.1786  -0.0769 0.0285  20.8443 -0.0049 -0.1114 -0.1919 -0.0818 -0.0805
0.051203818 0.2613  0.3705  -0.2308 0.2263  20.386  0.0411  -0.2653 -0.3731 -0.1452 -0.1138
0.051027422 0.3119  0.296   -0.2154 0.2063  20.0827 0.0001  -0.1801 -0.308  -0.1149 -0.0979
0.05    0.2923  0.1872  -0.0411 0.2973  19.2379 -0.0412 0.0007  -0.1412 -0.0362 -0.0536
0.050496084 0.0607  -0.0047 0.0795  0.1134  22.9053 -0.0128 -0.1831 -0.1179 -0.0411 -0.0162
0.048271605 0.0126  0.0235  0.1099  -0.028  23.6051 -0.0133 -0.1524 -0.0988 -0.0343 -0.0135
0.049775281 -0.069  0.1013  0.0317  0.0466  23.9102 0.0412  -0.0834 -0.0505 -0.0176 -0.0072
0.052298851 0.0428  -0.0393 0.0413  -0.002  20.1774 -0.0182 -0.0267 -0.0169 -0.0057 -0.0015
0.029964382 1.0297  0.9487  0.3805  -0.2863 19.876  -0.028  -0.3946 -0.8061 -0.2822 -0.2896
0.030064024 0.7462  0.7856  0.4003  -0.8022 19.9401 0.0099  -0.3375 -0.6214 -0.2022 -0.2202
0.029771863 0.1943  0.3069  0.1278  -0.0764 20.7356 0.0214  -0.201  -0.2314 -0.0803 -0.0801
0.029967219 0.6097  1.0436  0.2499  -0.2854 19.5447 0.0975  -0.2966 -0.6388 -0.2005 -0.2006
0.029967219 0.6032  1.0729  0.2347  -0.2514 19.5304 0.1064  -0.2898 -0.6387 -0.1988 -0.1961
0.029561001 0.0762  0.4975  0.0394  0.0531  19.4937 0.0973  -0.1007 -0.1962 -0.0527 -0.0609
0.029893162 0.4079  0.5162  0.2201  -0.0964 19.4996 0.0267  -0.2808 -0.4255 -0.1288 -0.1077
0.02989517  0.1036  0.2867  0.2034  -0.6605 20.4815 0.0435  -0.3753 -0.3434 -0.136  -0.0891
0.029368771 0.2517  -0.122  0.1413  0.1053  22.8562 -0.1044 -0.2149 -0.1313 -0.059  -0.0258
0.030744417 -0.0366 0.1 0.36    0.1425  22.1601 0.0388  -0.2119 -0.1263 -0.0423 -0.0166
0.030527066 0.0605  0.0156  0.1163  0.1053  22.9467 -0.0084 -0.1869 -0.1046 -0.0325 -0.0117
0.025472779 -0.0802 0.1143  0.0228  0.0797  22.7965 0.0308  -0.0895 -0.0507 -0.0157 -0.0059
0.028658537 0.0022  0.001   0.0104  0.0393  20.4577 -0.0018 -0.0254 -0.0161 -0.005  -0.0013
0.009635081 0.9427  1.0287  0.1853  -0.5212 19.3018 0.0112  -0.4171 -0.6989 -0.1768 -0.1968
0.009696013 0.3625  0.4577  0.6992  -0.1168 22.0062 0.0127  -0.7421 -0.496  -0.1835 -0.1374
0.008783505 -0.2244 0.5528  -0.5344 0.2846  23.32   0.1684  -0.408  -0.1525 -0.0474 -0.045
0.009706453 0.4968  0.5674  0.1102  -0.1253 27.1233 0.0164  -0.6966 -0.337  -0.1091 -0.0488
0.009640867 0.1605  0.9161  -0.0217 -0.2081 28.3212 0.1904  -0.5281 -0.225  -0.063  -0.0139
0.008682407 0.1811  0.0577  0.0417  0.1229  22.8415 -0.0466 -0.2902 -0.1218 -0.0373 -0.0238
0.010201005 0.3236  0.3774  0.0458  -0.1826 18.8125 0.0126  -0.1946 -0.2747 -0.0646 -0.0576
0.00981761  0.1816  0.1515  0.1407  0.4077  19.9347 -0.0096 -0.2701 -0.217  -0.0649 -0.0434
0.009687943 0.0098  0.0961  -0.0636 0.1616  21.7611 0.0203  -0.176  -0.0829 -0.0261 -0.0131
0.013419023 -0.1148 0.1603  0.4412  -0.3779 20.1353 0.0814  -0.0968 -0.0668 -0.0205 -0.0087];

A=[10   0.25    10
10  0.25    5
10  0.25    2.5
10  0.5 10
10  0.5 5
10  0.5 2.5
10  1   10
10  1   5
10  1   2.5
10  2.5 10
5   0.25    10
5   0.25    5
5   0.25    2.5
5   0.5 10
5   0.5 5
5   0.5 2.5
5   1   10
5   1   5
5   1   2.5
5   2.5 10
5   2.5 5
5   2.5 2.5
5   5   10
3   0.25    10
```

```
3   0.25    5
3   0.25    2.5
3   0.5 10
3   0.5 5
3   0.5 2.5
3   1   10
3   1   5
3   1   2.5
3   2.5 10
3   2.5 5
3   2.5 2.5
3   5   10
1   0.25    10
1   0.25    5
1   0.25    2.5
1   0.5 10
1   0.5 5
1   0.5 2.5
1   1   10
1   1   5
1   1   2.5
1   2.5 10];

beta=mvregress(F2,A);

Check2=[F2(1,:)*beta
    F2(2,:)*beta
    F2(3,:)*beta
    F2(4,:)*beta
    F2(5,:)*beta
    F2(6,:)*beta
    F2(7,:)*beta
    F2(8,:)*beta
    F2(9,:)*beta
    F2(10,:)*beta
    F2(11,:)*beta
    F2(12,:)*beta
    F2(13,:)*beta
    F2(14,:)*beta
    F2(15,:)*beta
    F2(16,:)*beta
    F2(17,:)*beta
    F2(18,:)*beta
    F2(19,:)*beta
    F2(20,:)*beta
    F2(21,:)*beta
    F2(22,:)*beta
    F2(23,:)*beta
    F2(24,:)*beta
    F2(25,:)*beta
    F2(26,:)*beta
    F2(27,:)*beta
    F2(28,:)*beta
    F2(29,:)*beta
    F2(30,:)*beta
    F2(31,:)*beta
    F2(32,:)*beta
    F2(33,:)*beta
    F2(34,:)*beta
    F2(35,:)*beta
    F2(36,:)*beta
    F2(37,:)*beta
    F2(38,:)*beta
    F2(39,:)*beta
    F2(40,:)*beta
    F2(41,:)*beta
    F2(42,:)*beta
    F2(43,:)*beta
    F2(44,:)*beta
    F2(45,:)*beta
    F2(46,:)*beta]
```

Appendix C: Equation 3 Coefficients for All Cracks

	S	a1	a2	b1	b2	w	c0	c1	c2	c3	c4
S1	0.1056	3.4753	2.4363	44.2958	51.7966	0.3107	-0.0682	-0.0727	0.4545	0.1997	-0.2797
S2	0.1056	3.2023	2.2033	48.5940	54.4606	0.0128	-0.0538	-0.0626	0.0597	0.0599	-0.0480
S3	0.1059	2.2593	1.3217	59.6988	65.9385	-0.0003	-0.0445	-0.0002	-0.0279	0.0130	0.0040
S4	0.0554	9.2678	7.8211	30.1511	33.3689	0.0001	-0.0219	-0.0001	-0.0052	-0.0038	-0.0038
S5	0.0553	7.6730	6.5462	32.4084	34.0776	-0.0149	-0.0260	0.0177	-0.0036	-0.0095	-0.0020
S6	0.0555	3.8799	3.0577	39.8680	34.6625	-0.0116	-0.0083	0.0042	-0.0055	-0.0064	-0.0005
S7	0.0351	11.1233	10.1643	23.1297	26.1257	0.4155	-0.0770	-1.0168	0.9842	-1.2523	1.9266
S8	0.0352	8.9205	8.4461	24.1856	24.9305	-0.6340	0.0344	0.4929	0.9511	-0.4355	-0.8642
S9	0.0352	3.6773	3.5120	26.8343	24.6556	-0.0765	0.0201	0.0243	0.0238	-0.0096	-0.0167
S10	0.0149	12.2725	12.7173	21.1094	23.1490	0.0036	-0.0008	-0.0320	-0.0105	0.0096	0.0003
S11	0.0148	9.7637	10.4190	20.2938	22.0737	-0.0050	0.0108	-0.0218	-0.0126	0.0106	-0.0036
S12	0.0144	3.0749	4.4624	16.1899	16.7177	-0.0010	0.0823	0.0131	-0.0417	0.0313	-0.0070
I1	0.1000	0.1340	0.0714	0.0356	0.3116	32.2575	-0.0241	-0.2258	-0.1930	-0.1267	-0.0465
I2	0.1002	0.0625	0.1378	0.1048	-0.0125	32.3526	0.0169	-0.1816	-0.1671	-0.1101	-0.0549
I3	0.1002	0.0694	0.0299	0.1365	0.0425	33.1037	-0.0110	-0.0892	-0.0879	-0.0639	-0.0358
I4	0.1002	0.1525	0.0401	0.1654	0.1364	31.0187	-0.0270	-0.1801	-0.1553	-0.0895	-0.0386
I5	0.1001	0.0961	0.0666	0.2060	-0.0203	31.5537	-0.0082	-0.1506	-0.1334	-0.0805	-0.0353
I6	0.1001	0.0425	0.0290	0.0399	0.1035	32.4888	-0.0067	-0.0755	-0.0715	-0.0485	-0.0244
I7	0.1000	0.0740	0.0183	-0.0106	0.0174	29.3038	-0.0174	-0.1309	-0.1064	-0.0531	-0.0202
I8	0.1001	-0.1010	0.1784	0.0851	-0.0330	29.1978	0.0677	-0.1121	-0.0934	-0.0474	-0.0193
I9	0.1006	0.0545	0.0267	0.0304	0.0059	30.7046	0.0004	-0.0550	-0.0471	-0.0271	-0.0103
I10	0.0994	0.0558	-0.0660	0.0481	-0.0564	25.5667	-0.0367	-0.0515	-0.0381	-0.0150	-0.0063
I11	0.0511	0.4391	1.0487	0.5683	-0.4263	20.8414	0.1683	-0.3233	-0.6259	-0.2545	-0.2460
I12	0.0512	0.3711	0.6308	0.6410	-0.4959	31.5229	0.0634	-0.6453	-0.4616	-0.2571	-0.1056
I13	0.0513	0.2279	0.1916	-0.0344	-0.0352	21.4217	-0.0049	-0.1498	-0.2321	-0.1108	-0.1055
I14	0.0510	0.4648	0.2371	0.8147	-0.2069	28.2731	-0.0499	-0.6914	-0.4839	-0.2251	-0.1037
I15	0.0508	0.4495	0.5879	0.2354	-0.3850	20.0688	0.0289	-0.1531	-0.4295	-0.1624	-0.1674
I16	0.0510	0.2074	0.1786	-0.0769	0.0285	20.8443	-0.0049	-0.1114	-0.1919	-0.0818	-0.0805
I17	0.0512	0.2613	0.3705	-0.2308	0.2263	20.3860	0.0411	-0.2653	-0.3731	-0.1452	-0.1138
I18	0.0510	0.3119	0.2960	-0.2154	0.2063	20.0827	0.0001	-0.1801	-0.3080	-0.1149	-0.0979
I19	0.0500	0.2923	0.1872	-0.0411	0.2973	19.2379	-0.0412	0.0007	-0.1412	-0.0362	-0.0536
I20	0.0505	0.0607	-0.0047	0.0795	0.1134	22.9053	-0.0128	-0.1831	-0.1179	-0.0411	-0.0162
I21	0.0483	0.0126	0.0235	0.1099	-0.0280	23.6051	-0.0133	-0.1524	-0.0988	-0.0343	-0.0135
I22	0.0498	-0.0690	0.1013	0.0317	0.0466	23.9102	0.0412	-0.0834	-0.0505	-0.0176	-0.0072
I23	0.0523	0.0428	-0.0393	0.0413	-0.0020	20.1774	-0.0182	-0.0267	-0.0169	-0.0057	-0.0015
I24	0.0300	1.0297	0.9487	0.3805	-0.2863	19.8760	-0.0280	-0.3946	-0.8061	-0.2822	-0.2896
I25	0.0301	0.7462	0.7856	0.4003	-0.8022	19.9401	0.0099	-0.3375	-0.6214	-0.2022	-0.2202
I26	0.0298	0.1943	0.3069	0.1278	-0.0764	20.7356	0.0214	-0.2010	-0.2314	-0.0803	-0.0801
I27	0.0300	0.6097	1.0436	0.2499	-0.2854	19.5447	0.0975	-0.2966	-0.6388	-0.2005	-0.2006
I28	0.0300	0.6032	1.0729	0.2347	-0.2514	19.5304	0.1064	-0.2898	-0.6387	-0.1988	-0.1961
I29	0.0296	0.0762	0.4975	0.0394	0.0531	19.4937	0.0973	-0.1007	-0.1962	-0.0527	-0.0609
I30	0.0299	0.4079	0.5162	0.2201	-0.0964	19.4996	0.0267	-0.2808	-0.4255	-0.1288	-0.1077
I31	0.0299	0.1036	0.2867	0.2034	-0.6605	20.4815	0.0435	-0.3753	-0.3434	-0.1360	-0.0891
I32	0.0294	0.2517	-0.1220	0.1413	0.1053	22.8562	-0.1044	-0.2149	-0.1313	-0.0590	-0.0258
I33	0.0307	-0.0366	0.1000	0.3600	0.1425	22.1601	0.0388	-0.2119	-0.1263	-0.0423	-0.0166
I34	0.0305	0.0605	0.0156	0.1163	0.1053	22.9467	-0.0084	-0.1869	-0.1046	-0.0325	-0.0117
I35	0.0255	-0.0802	0.1143	0.0228	0.0797	22.7965	0.0308	-0.0895	-0.0507	-0.0157	-0.0059
I36	0.0287	0.0022	0.0010	0.0104	0.0393	20.4577	-0.0018	-0.0254	-0.0161	-0.0050	-0.0013
I37	0.0096	0.9427	1.0287	0.1853	-0.5212	19.3018	0.0112	-0.4171	-0.6989	-0.1768	-0.1968
I38	0.0097	0.3625	0.4577	0.6992	-0.1168	22.0062	0.0127	-0.7421	-0.4960	-0.1835	-0.1374
I39	0.0088	-0.2244	0.5528	-0.5344	0.2846	23.3200	0.1684	-0.4080	-0.1525	-0.0474	-0.0450
I40	0.0097	0.4968	0.5674	0.1102	-0.1253	27.1233	0.0164	-0.6966	-0.3370	-0.1091	-0.0488
I41	0.0096	0.1605	0.9161	-0.0217	-0.2081	28.3212	0.1904	-0.5281	-0.2250	-0.0630	-0.0139
I42	0.0087	0.1811	0.0577	0.0417	0.1229	22.8415	-0.0466	-0.2902	-0.1218	-0.0373	-0.0238
I43	0.0102	0.3236	0.3774	0.0458	-0.1826	18.8125	0.0126	-0.1946	-0.2747	-0.0646	-0.0576
I44	0.0098	0.1816	0.1515	0.1407	0.4077	19.9347	-0.0096	-0.2701	-0.2170	-0.0649	-0.0434
I45	0.0097	0.0098	0.0961	-0.0636	0.1616	21.7611	0.0203	-0.1760	-0.0829	-0.0261	-0.0131
I46	0.0134	-0.1148	0.1603	0.4412	-0.3779	20.1353	0.0814	-0.0968	-0.0668	-0.0205	-0.0087

Bibliography

Aggelis, D., Kordatos, E., Soulioti, D., and Matikas, T. (2010). "Combined use of thermography and ultrasound for the characterization of subsurface cracks in concrete." *Construction and Building Materials*, 24(10), 1888–1897.

Aggelis, D., Kordatos, E., Strantza, M., Soulioti, D., and Matikas, T. (2011). "NDT approach for characterization of subsurface cracks in concrete." *Construction and Building Materials*, 25(7), 3089–3097.

Almond, D. P., and Pickering, S. G. (2012). "An analytical study of the pulsed thermography defect detection limit and the defect aspect ratio greater than two rule-of-thumb." *Journal of Applied Physics*, 111.

ASNT. (2017). "About ASNT." *Introduction to Nondestructive Testing*, <https://www.asnt.org/MinorSiteSections/AboutASNT/Intro-to-NDT.aspx> (Aug. 1, 2017).

ANSYS. (1998). *ANSYS Alternate Online Manual Set, Release 5.5*, <http://www.ansys.stuba.sk/html/realtoc.html.> (Jul. 5, 2017).

Avdelidis, N. P., Gan, T-H., Iberra-Castanedo, C., and Maldague, X.P.V. (2011). "Infrared Thermography as a Non-Destructive Tool for Materials Characterisation and Assessment." *Thermosense: Thermal Infrared Application XXXIII*.

Barile, C., Casavola, C., Pappalettera, G., and Pappalettere, C. (2016). "Analysis of crack propagation in stainless steel by comparing acoustic emissions and infrared thermography data." *Engineering Failure Analysis*, 69, 35–42.

Broberg, P. (2013). "Surface crack detection in welds using thermography." *NDT & E International*, 57, 69–73.

Burrows, S. E., Rashed, A., Almond, D. P., and Dixon, S. (2007). "Combined laser spot imaging thermography and ultrasonic measurements for crack detection." *Nondestructive Testing and Evaluation*, 22(2-3), 217–227.

ECCS. (2015). *Fire design of steel structures: ec1 - actions onstructures actions on str. exposed to fire. ec3 ... design of steel structures part 1-2*. Wilhelm Ernst & Sohn Verl, Place of publication not identified.

Eom, C.-D., Han, Y.-J., Kim, K.-M., Kim, K.-B., Lee, J. J., and Yeo, H. (2008). "Detection Of Defects In Lumber Using Ir Thermography." *Advanced Nondestructive Evaluation II*.

Farrar CR, and Worden K. (2007). "An Introduction to Structural Health Monitoring." *Philosophical Transactions. Series a, Mathematical, Physical, and Engineering Sciences*, 365(1851), 303–315.

FLIR. (2014). "T-Series: Thermal Imaging Cameras for Predictive Maintenance."

Incropera, F. P., Dewitt, D. P., Bergman, T. L., and Lavine, A. S. (2007). *Fundamentals of Heat and Mass Transfer*. Wiley, Hoboken, NJ.

Li, T., Almond, D. P., Rees, D. A. S., and Weekes, B. (2010). "Crack imaging by pulsed laser spot thermography." *Journal of Physics: Conference Series*, 214, 012072.

Li, T., Almond, D. P., Rees, D. A. S., Weekes, B., and Pickering, S. G. (2010). "Pulsed Laser Spot Imaging Thermography, Modelling And Experimental Data." *AIP Conference Proceedings*.

McMasters, R. L., Taylor, R. P., and Brooke, G. M. (2017). "Nondestructive Testing of Materials Using Thermal Imaging." *Journal of Thermosphysics and Heat Transfer*, 31(1), 230–236.

Plum, R., and Ummenhofer, T. (2013). "Use of Ultrasound Excited Thermography Applied to Massive Steel Components: Emerging Crack Detection Methodology." *Journal of Bridge Engineering*, 18(6), 455–463.

Rashed, A., Almond, D. P., Rees, D. A. S., Burrows, S., and Dixon, S. (2007). "Crack Detection by Laser Spot Imaging Thermography." *AIP Conference Proceedings*.

Shepard, S. M. (1997) "Introduction to Active Thermography for Non-Destructive Evaluation." *Anti-Corrosion Methods and Materials*, 44(4), 236–236.

Shim, H. (2003). "Performance Evaluation of Nde Methods." *Ksce Journal of Civil Engineering*, 7(2), 185–192.